REPORT

OF THE

COMMISSION ON INDUSTRIAL EDUCATION,

MADE TO THE

LEGISLATURE OF PENNSYLVANIA,

WITH APPENDICES.

HARRISBURG:
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1889.

VIRTUE LIBERTY AND INDEPENDENCE.

IN THE SENATE, *April 26th*, *1889*.

Resolved, by the Senate, (if the House of Representatives concur,) That ten thousand copies of the report of the Commission on Industrial Education be printed and bound: Five hundred copies for the use of the Governor, five hundred copies for the use of the State Librarian, one thousand copies for the use of the Commission, one thousand copies for the use of the Superintendent of Public Instruction, two thousand copies for the use of the Senate, and five thousand copies for the use of the House of Representatives; one-tenth of the edition to be bound in half morocco, and the remaining nine-tenths in cloth.

RUSSELL ERRETT,
Chief Clerk of the Senate

JOHN W. MORRISON,
Chief Clerk of the House of Representatives.

APPROVED—The 3d day of May, A. D. 1889.

JAMES A. BEAVER.

PREFATORY NOTE.

The Commission is under obligation to so many institutions and individuals, for favors received in the course of its work, that it would be impossible to mention all. It may be said in general, that nearly everyone who has been applied to for information has responded with a promptness, ful'ness and courtesy which has not only greatly lightened the labors of the Commission, but has given gratifying evidence of the wide-spread interest in the subject of its inquiries. It is due, however, that special recognition should be made of the unfailing assistance rendered by His Excellency the Governor of the Commonwealth, and his secretary Hon. Gearge Pearson, by the State Superintendent of Public Instruction and by all other State officials whom it has been found necessary to call upon. Valuable assistance has also been received from Superintendent MacAllister, the Hon. Edward T. Steel, Miss Catherine Pendleton, Miss Anna Hallowell and others, of Philadelphia; from numerous State and local school officials outside of Pennsylvania, and from the heads of institutions specially devoted to Manual Training in many parts of the United States. In connection with the inquiries made under its direction in Europe, invaluable assistance was rendered by Sir Lyon Playfair, Sir Henry E. Roscoe, the Rt. Hon. John Morley, Prof. James Bryce, Mr. A. H. D. Ackland, M. P., Mr. Quentin Hogg, Sir Philip Magnus, Dr. J. H. Gladstone, Prof. Sylvanus Thompson, the Rev. Alfred Wills and Mr. Gilbert R. Redgrave, Secretary of The Royal Technical Commission, of London; by the Hon. William Mather, of Manchester; by MM. Buisson, of the Department of Public Instruction, Andre Lebon and R. Chasteauneuf, of Paris; by MM. Buls, Burgomaster of Brussels, and A. Sluys, director of the normal school in the same place. It is a special pleasure to record also that the members of the United States Diplomatic and Consular service, at the places above mentioned and at Antwerp, were, without exception, prompt and cordial in facilitating the labors of the Commission.

REPORT

OF THE

Commission Appointed to make Inquiry and Report to the Legislature of Pennsylvania Respecting the Subject of Industrial Education.

To the Senate and House of Representatives of the Commonwealth of Pennsylvania:

The Commission appointed to make inquiry respecting the subject of Industrial Education, respectfully submits the following report:

The Legislature at its last session adopted the following concurrent resolution:

"*Resolved* (if the House of Representatives concur), That the Governor is hereby authorized and requested to appoint a Commission consisting of not more than five persons, citizens of this Commonwealth, to make inquiry and report to the Legislature at its next session, by bill or otherwise, respecting the subject of industrial education, including an examination of the extent to which it is already carried on in Pennsylvania and elsewhere; the best means of promoting and maintaining it in its several grades, whether by State or local action alone, or by both combined; how far it is possible or desirable to incorporate it into the existing system of public instruction; the best method of training teachers for such schools or departments, and what changes, if any, are required in the existing system of normal schools to enable them to provide such training, or to meet more fully the needs of the system of public instruction as now organized in this State, with such other inquiries as the Commission may itself institute or be requested by the Governor to undertake. The members of the Commission shall serve without compensation, except for necessary expenses and clerk hire actually incurred and approved by the Governor."

This resolution was approved by his Excellency the Governor, May 19, 1887, and the following gentlemen were subsequently "appointed to serve on the said Commission": George W. Atherton, LL. D., President of The Pennsylvania State College; Adam H. Fetterolf, LL. D., President of Girard College; Nathan C. Schaeffer, Ph. D., Kutztown, Pa.; George J. Luckey, Esq., Pittsburgh, Pa.; Colonel Theodore W. Bean, Norristown, Pa.

The Commission held its first meeting in the Supreme Court chamber, Harrisburg, December 9, 1887, and organized by appointing George W. Atherton, chairman, and Samuel A. Boyle, clerk. After a consideration of the terms of the resolution, the following specific topics of inquiry were adopted as embodying its essential points:

1. To what extent in its several grades, and by what methods, industrial education is carried on outside of Pennsylvania as a branch of public education.

2. To what extent and by what methods it is now carried on in the several grades of public schools in Pennsylvania, and the practicability of introducing or extending it in such schools, city and rural.

3. (*a*) To what extent in its several grades, and by what methods it is now carried on in private institutions in Pennsylvania, with the relation of such work to other forms of education, to public charities and reformatories, to industrial development, and to the general interests of society.

(*b*) The best methods of enlarging and extending such work, having in view also the question of its more or less direct connection with existing public systems or agencies.

4. (*a*) The best means and methods of establishing and maintaining it in its several grades: Whether by State action, or by local action, or by both combined.

(*b*) How far it can be incorporated into the present school system of Pennsylvania, and what (if any) changes of law are necessary or desirable to that end.

5. The best methods of training suitable teachers.

(*a*) Changes (if any) required for this purpose in the present system of normal schools.

(*b*) Changes (if any) required to enable the normal schools to meet more fully the needs of the present public school system.

6. As to each of the foregoing topics:

How far the educational element should be incorporated into such training, as distinguished from the strictly trade, apprentice, or technical element.

In order to make the proposed investigation as thorough as possible in the several directions thus suggested, it was thought desirable to assign these special lines of inquiry to the different members of the Commission, the results in each case to be finally reviewed by the Commission as a whole.

The following resolution was also adopted:

"*Resolved*, That the chairman be and hereby is authorized and requested, on behalf of the Commission (and as far as practicable) to visit such places and institutions in Europe as furnish the most systematic and successful instances of industrial education, as far as he may deem inquiries in that direction likely to aid the Commission in discharging the duties intrusted to it by the Commonwealth."

The individual members of the Commission have pursued the several lines of inquiry thus indicated, and the Commission, as a body, has met from time to time to compare views and to combine the results of investigation, continuing that procedure until shortly before the assembly of the present Legislature. They have singly or as a body visited many portions of our own State; have conferred with leading

representatives of educational and business interests in Philadelphia, Pittsburgh and elsewhere; have visited a few institutions in other States; and the chairman, at the request of the Commission, and with the approval of the Governor, spent between two and three months in an investigation of the same subject in England, France and Belgium. Besides this, the members of the Commission have sought to make use of all available sources of information in the way of printed reports, discussions, treatises, etc., and, divesting themselves of all preconceived opinions which could interfere with the thoroughness and impartiality of their work, have diligently addressed themselves to the inquiries marked out for them by the resolution above quoted.

It should perhaps be said at the outset, that without neglecting other branches of inquiry, they have considered themselves especially charged with the question as stated in the words of the resolution, "How far it is possible or desirable to incorporate it [industrial education] into the existing system of public instruction, and the best method of training teachers for such schools or departments." In order to reach definite results, they have endeavored to ascertain,

First. To what extent and with what results such instruction has been actually established as a part of public school education in the United States and elsewhere;

Second. Whether the introduction of such instruction in the public schools of this State is desirable; and,

Third. Whether, if desirable, it is also practicable.

In the appendices to the report will be found a large amount of material, embodying the results of such inquiry, showing to what extent industrial education has been successfully established in many places, at home and abroad, and presenting the views of eminent men in the various walks of life as to its general results. This material cannot profess to be more than a meagre selection from the great mass within reach. The difficulty has been not to find material enough, but to select from the profusion accessible, what seemed likely to prove the most useful portions. The guiding principle in this selection has been to present the results of actual experience in different branches of the work; and, in the hope of furnishing practical assistance to institutions and localities, a few courses and methods now in successful operation are given, with some statements of the expense involved. Theoretical views have been given weight only so far as they have proved the basis of sound experience.

It is perhaps desirable to indicate the sense in which the term industrial education is here used. In recent discussions the terms "technical education," "scientific education," "industrial education," "manual training," etc., frequently occur, and it is doubtful whether a clear distinction as to the field they cover is always held in mind by those using them. It is perhaps impossible that such a distinction should be made in a way to meet the approval of all educators, but

the view upon which the Commission has proceeded, which has given direction and coloring to all its investigations, and which has embodied itself in the conclusions presented in this report, may be stated substantially as follows:

Scientific education may be regarded, in one view, as almost exclusively theoretical; in another, as almost exclusively practical;—this being the familiar distinction between pure and applied science. But since no branch of science can be effectively taught, except as to its theory, without the aids of the laboratory and the actual manipulation of materials and apparatus, all scientific instruction comes to have, almost of necessity, a semi-technical cast. If carried one step farther, and conducted with reference to its general applications in industry, it becomes a general technical instruction; if applied to specific industries, it becomes special technical or technological instruction.

Technical instruction, therefore, may be regarded as the teaching of science with specific reference to its applications in the various forms of industry, including also a knowledge of the materials and the practical processes employed in them; and the term has come to be applied almost, if not quite universally, to the higher ranges of such instruction.

Industrial education does not differ from general technical education except that the term may properly be considered applicable to the lower ranges instead of the higher; and while no line of demarcation between the two can be sharply drawn, the distinction here made may serve to indicate with sufficient accuracy the respective fields covered by each.

Manual training in the strict sense of the term, would mean simply the training of the hand; but as currently used with reference to education, the words indicate such employment of the hand, as will, at the same time, train the eye to accuracy and the mind to attention. The scientific element, or the teaching of science pure and simple, is not necessarily involved in the expression. As, however, pure science can scarcely be taught without looking somewhat toward its applications, so manual training cannot be made an effective educational process except by constant reference to the broad foundation in the mathematical, physical and natural sciences upon which it rests.

The Commission has deemed that for its purposes the term "Industrial Education" as used in the resolution authorizing its appointment, was ample and expressive. It involves both the idea of manual training with reference to its industrial applications, and the idea of educational or intellectual training which, with reference to industries, must be largely on the scientific side. Industrial education, therefore, we understand and use as meaning primarily *education;* education with reference to practical life, but still *education;* the training of the hand, the eye and the brain to work in unison; the training of the whole child in such a way that his inward powers may

act effectively through fit instruments upon his external surroundings, and receive from them in turn accurate and informing impressions.

It is not the purpose of the Commission to appear as a critic, much less an opponent of the public school system as it now exists. Its favorable influence in the development of American character and American institutions can scarcely be overestimated. Beginning with the beginnings of our national life, and growing with its growth, it has wrought itself into the very fiber of our social and political structure, and has proved for the great mass of our people a means of uplifting and advancement second to no other agency. But the conditions out of which the system grew have so largely changed, that some modification in its methods, though not in its essential spirit, is absolutely necessary. The widespread introduction of scientific knowledge and scientific methods into all the industrial processes of the day, makes it necessary that the great mass of our children, who leave school at the age of fourteen or sixteen—and under, if they are not to be launched unprepared into an unknown world, must acquire such training in the public school as will give them at least some elementary knowledge of the facts and the forces with which they will be brought face to face as soon as the doors of the school house close behind them.

The fact should be frankly recognized and emphasized that our better public schools have, for the last twenty-five years, been moving in this direction, and have made immense advancement; but it is still true to a far greater extent than it ought to be that their tendency is to educate boys and girls away from the ideas of practical, self-helpful, industrial life rather than toward it. This fact has come to be widely recognized by thoughtful observers among ourselves, as well as by citizens of other countries who have made a study of our educational system. One of our friendliest and most judicious critics, Mr. William Mather, of Manchester, in his report made to the Royal Commission on Technical Instruction, says:

* * * * * "Too large a class of young people in America of both sexes are seeking pursuits not requiring manual labor. Their education, as given at present in the high schools and colleges, tends rather to unfit them for the active industries of life, in a country where the vast resources of nature are waiting for willing and trained hands to utilize them. The native-born American hates drudgery; and all the mechanical arts, when pursued without some knowledge of science to employ and interest the mind while the hands are active, are more or less drudgery. The American boy, with his inborn ambition and natural ingenuity, would cease to regard manual labour as drudgery if his hand and mind together were industrially trained through the school period. He would then be led into industrial employments by choice, as the readiest means to climb to a higher position in life.

"It cannot be denied, however, that a widespread aptitude to learn and understand, has been implanted by the public schools of America. A high degree of self respect marks the workmen who have passed through the schools, and to those '*who have it in them*,' the education even of the grammar school, closing at fourteen to fifteen years old, enables self-improvement to be continued by boys of talent and energy, without great difficulty, even through private study."

These and similar observations might be quoted from many sources, and the criticism which they emphasize would, until within a very few years, have been equally applicable in every other country which maintains a system of general education.

The defect being everywhere felt, a remedy has been everywhere sought. The advances in scientific knowledge within the present century have not been more remarkable than the change in educational methods resulting from them. The effort has been not merely to make use of the new material for education brought forward by the discoveries of science, nor merely to inculcate the scientific method in the use of this material, but to combine these two elements of training with the appreciation of both material and method to the new conditions of social and industrial life. Either might have been done without the other; but the attempt to conduct educational processes in such a way as to apply scientific discovery to actual life, has resulted both in carrying the educational spirit forward into industrial pursuits, and in bringing the active, alert and vigorous industrial spirit into the methods of education. The general result has been a great and far-reaching educational movement within the last fifty years, surpassed—if equalled—by no similar movement in the history of mankind. Every civilized country, and the best minds in every country, have thought it worth while to encourage, foster and promote this movement. Technical education, in some one or other of its many forms, has come to be established in every country of the civilized world; but by an inversion of what would seem the natural and logical order, the beginning has in all cases been made at the top rather than at the bottom of the system.

Governments everywhere have considered it expedient to establish special institutions for the training of the higher and official class, and even in countries where classes are less distinctly recognized, the more advanced forms of technical instruction have received the earliest attention. Within the last few years, however, a notable movement has set in for the diffusion of scientific and technical instruction among the masses of the people. In Sweden, Finland, Switzerland and France such instruction is already widespread. France especially has made it the object of the government's most solicitious care for the last nineteen years. Other countries have made and are still making promising beginnings in the same direction.

Russia has no system of public education, but some of her institutions of technical instruction are among the best in the world.

The excellence and extent of the German and Austrian systems are well known.

Great Britain has for forty years past maintained a splendid system of general art education, and is now moving slowly but surely and vigorously in the direction of technical and industrial education. Several colleges, like Owens College at Manchester, the Yorkshire

College at Leeds, University College at Liverpool, and others, have already introduced it; the London (Finsbury) Technical College is carrying it on in the most successful manner, under the intelligent and efficient direction of Professor Thompson; a national association for the promotion of technical education has within a year past been formed, with Lord Hartington at the head, and other eminent public men among its active managers; the London School Board has introduced manual training into some of its schools within the last twelve months, and, through the newly established institution known as The City and Guilds of London Institute, under the management of Sir Phillip Magnus, a systemantic propaganda of the new ideas and methods is being actively carried on. At the last two sessions of Parliament a bill has been introduced for the promotion of technical education, but has failed each time; in the first instance because the measure was unsatisfactory to its most intelligent friends, and in the second, for want of time. But there is no doubt of the enactment at no distant day of some comprehensive scheme of this kind.

In the year 1881 the British government appointed a Royal Commission on Technical Instruction, the members of which, in a body or singly, visited most of the leading countries of Europe, and made most extensive and thorough inquiries into the state of technical instruction of all grades therein; and their report, embodying the results of inquiries and observations thus made, is a most valuable collection of matetial not elsewhere so easily accessible. This report, selections from which will be found in the appendix, presents the views of eminent educators and of men engaged in industrial persuits, either as managers, foremen or proprietors, and presents them not simply with reference to the educational value of technical instruction, but even more with reference to its value as a factor in industrial life.*

The movement in the same direction in the United States has not been less marked or important. It may be said to have taken definite form in 1862, in the passage by Congress of the well-known land-grant act. This measure has proved of great and far-reaching importance; and, whatever regrets may be felt that it has not in all cases fully met the expectations of its original promotors, it has been fruitful of untold benefit to the cause of scientific and technical education throughout the United States. It provided for the establishment, in every State and Territory which should accept its provisions, of at least one college where "the leading object" should be "to teach such branches of learning as are related to agriculture and the me-

*The foregoing statements take no account of the vast number of trade schools, evening classes, mechanics' institutes, and similar agencies for giving specific technical instruction to apprentices and others actually employed in trades. These are to be found in nearly every important industrial centre in Europe, and are exerting in the aggregate an immense influence for good. But they can scarcely be classed as educational institutions in the proper sense of the word.

chanic arts, without excluding other scientific and classical studies, and including military tactics."

Unfortunately, from an educational point of view, the grant of public lands in support of this measure (30,000 acres for each Senator and Representative in Congress) was proportioned on a basis which had no relation to the educational needs of the respective States. The smaller and newer States, which needed most receive least; and, while this inequality has been in many cases rectified by the action of the State governments, the original disvantage has never fully disappeared. Notwithstanding all drawbacks, however, the result has been that the National initiative, supplemented by the action of the States and of individuals, has resulted in establishing a large number of vigorous, progressive and successful institutions, which have, for the first time in the history of the United States, made the teaching of science in its applications their leading object, without excluding such other branches of learning as are specially adapted to give force and refinement to the intellect. Many of these institutions have established and have now in successful oparation departments of instruction in the mechanic arts and mechanical engineering in all their varied branches. Some of these institutions are directly connected with the State system of public schools, and they have thus exercised an important influence in diffusing the principles of an education at once liberal and practical throughout the entire body. It is impossible to say how far their influence has directly affected the older classical colleges, or how far both have been carried along by a general movement stronger than either; but certain it is, that since their establishment the methods of instruction in the older colleges have been greatly modified, and the subject matter of their curriculum greatly extended by the introduction of scientific studies.

Not the least important service conferred upon the people of the country by the act of Congress just mentioned, has been the creation of a large body of men engaged in teaching and popularizing modern science, and especially manual training in connection with agriculture and the mechanic arts. Their influence in this respect has already been widely felt and promises to be still more so in the new movement for popularizing manual training as a part of public school instruction.

The latter movement is now under way to an extent and with a force which is probably not appreciated by any who have not given special attention to the subject. It began about ten years ago with the establishment of the St. Louis Manual Training School. Since that time, but particularly within the last five years, it has spread very rapidly, until it has come to be to day a factor of the greatest importance in public education in many parts of the country. An account of the most important institutions of this kind in the United States will be found in the appendix. It is enough for our present purpose to ob-

serve that they have taken the form either of special institutions, privately supported, or of institutions forming a branch of the general school system of the town or city in which they are established, or of a special course in connection with one or more schools.

What now, is the purpose and meaning of this movement? What is manual training in the public schools? What is it designed to accomplish? By what methods is it carried on? What is its relation to established courses, what are its results thus far, and to what extent is it demanded or justified by public opinion? Upon these points we proceed to give the conclusions reached by our own inquiries, with the testimony of many competent observers.

As has been already indicated, manual training does not mean simply the use of the hand, nor does it mean simply the training of the hand for the sake of the hand, or for the sake of the productive skill which that training gives. It is a training of the hand for the purpose of securing at the same time and primarily, the training of the mind, through the senses of touch and perception. The hand cannot be trained to accurate methods without at the same time holding the eye to accurate observation; and hand and eye cannot be trained to accurate observation and manipulation without at the same time exercising the mental faculties of attention, comparison, reflection and judgment. The use of tools upon material substances develops this entire circle of faculties; develops them in such mutual relation that each supports and is supported by the others. It is surprising to see the readiness with which children even as young as seven or eight years enter into the spirit of this training, and find delight in the exercise of the constructive faculty, which almost everywhere among children manifests itself when the opportunity is given.

But mere work of this kind, however varied, would tend to become monotonous, and run into routine. Accordingly the manual training schools introduce into their curriculum the same educational studies as are found in other schools, and aim thus to develop the intellectual faculties not less than the physical. In the same way shop work, when introduced as a part of the prescribed course of any public school, is not allowed to diminish the amount of attention given to other studies; and it is found that the school time which would thus at first sight appear to be lost to other studies, is fully made up, and often more than made up, by the increased freshness, aptitude, and mental alertness which the pupil acquires from his manual exercises. The testimony of experienced observers is absolutely uniform, that boys who receive this double training are in no respect losers in their intellectual studies by reason of the time spent in the work shop, but are in many, if not a majority of cases, absolute gainers.

The principal of the Boston High School, reporting upon the experiment of a class in manual instruction, says:

"It was thought that taking a part of the class away from its regu-

lar school work would result in more or less detriment to its progress in the prescribed studies. Here and there a complaint was made by the teacher, of some second-class boy, that he was not doing his work well in his own room; but the pupil, in every case, was so anxious to remain in the 'carpenter's class' that a word or two of warning was sufficient to bring his performance up to a standard again. The result, so far as the first class is concerned, has been tabulated, and will be found in the paper marked 'C.' On an examination of this paper it will be seen that *no boy fell below the required per cent, and each boy received his diploma. I consider that the results go far to prove that manual training is so great a relief to the iteration of school work that it is a positive benefit rather than a detriment to the course in the other studies.*"

The report of the St. Louis Manual Training School for 1887-8 says:

"In a manual training school properly so-called, no attempt is made to cultivate dexterity at the expense of thought. No mere sleight-of-hand is aimed at, nor is muscular exercise of itself held to be of educational value. An exercise, whether with tools or with books, is valuable only in proportion to the demand it makes upon the mind for intelligent, thoughtful work. In the school shop the stage of mechanical habit is never reached. *The only habit actually acquired is that of thinking.* No blow is struck, no line drawn, no motion regulated, from muscular habit. The quality of every act springs from the conscious will, accompanied by a definite act of judgment. Such a limited training cannot, of course, produce a high degree of manual skill."

To the same effect the second annual report of the Toledo Manual Training School says:

"In manual education, the desired end is the acquirement of skill in the use of tools and materials, and not the production of specific articles; hence we abstract all the mechanical processes and manual arts and typical tools of the trades and occupations of men, arrange a systematic course of instruction in the same, and then incorporate it into our system of education. Thus, without teaching any one trade we teach the essential mechanical principles of all."

The course of study pursued in any of the schools described in the appendix, will sufficiently exhibit the manner of combining these branches of instruction and exercises, and need not be quoted here. It may be said in general, that the special manual training schools aim to give the full equivalent of an ordinary high school education, with the additional of a continuous course in drawing and shop work through the entire three years; but it should be especially observed that all such schools resolutely disclaim a purpose to teach trades, but insist, rather, upon teaching the principles and processes underlying all trades. While the shop exercises are found to have a highly beneficial influence physically, their main purpose and their main result is intellectual; while they give the boy or girl knowledge and skill in

the use of the hand, they give greater facility and skill in the use of the thinking faculty. This result is greatly aided by the introduction of drawing and design into all manual training courses. Besides forming a most important connecting link between the school and practical industries, drawing has an educational value which is universal in its character. It develops closeness of observation, accuracy of perception, vividness of imagination, quickness of eye, facility of hand, care and judgment in expression. It cultivates a knowledge of relations, of fittingness and adaptation, all useful in the general duties of life, and which render their possessor either better producers or better able to appreciate the products of labor into which the element of design enters. There are few States in the Union in which the subject of industrial drawing is so important as in Pennsylvania.

Nearly all eminent thinkers are agreed, in the theory at least, that education should proceed from the simple to the complex; from the concrete to the abstract; from things to the representatives, or ideas of things. As Rousseau says, "The child should first learn the things nearest to him, then those that are farther and farther off." There would seem to be no room to doubt that a systematic course of education, conducted upon this principle, would result in a symmetrical and well-compacted development of the child's mental and physical being, which would fit him for the duties of practical life far more effectively than any one-sided training, however excellent, could possibly do. By dealing with the facts, the forces, the laws and the materials of the world about him, the pupil soon learns that he can become their master only by studying their nature and obeying their laws. He thus acquires an intellectual habit of docility, of teachableness, of patience and of attention to detail which is of incalculable advantage to him as a learner, and which falls directly in line with his growing experience of the discipline of actual life. He becomes a learner that he may rule, and he thus comes in his early years to look upon the fixed facts of existence from the point of view from which real life will present itself to him a little later. He learns to deal with real problems in the precise manner in which he must deal with similar problems on a larger scale when he comes presently to meet the experiences of responsible life. He learns the only way of making life successful. It is upon this ground that the advocates of manual training base their claims.

Another consideration of the very highest importance has been already alluded to. The period of school-life is for most children the formative period. Their tastes, their aptitudes, their tendencies then take shape and determine very largely the direction of their future career. If, during this critical period, they learn to look upon labor not only as honorable, but as the natural concern of men; if, beyond that, their labor is, at every step, connected with a knowledge of the principles underlying it, so that manual employment goes hand in

hand with intelligence, the effect upon the child's mental altitude in his outlook towards life cannot fail to be decisive. As Dr. W. T. Barnard says [Report, p. 76]:

"By giving more attention to scientific instruction, and to the training of the hand and eye, our public schools would not only do much towards meeting the present requirements of industry, but the reaction upon the schools themselves would be highly beneficial, and intellectual training would assume a high value in all grades of society. Teach the boys in our public schools that to be a carpenter, a machinist, or a molder, is just as honorable, requires no less skill, and may be more profitable, than to be a clerk, or a doctor, or a lawyer, and there will be hundreds of qualified applicants for apprenticeship in our best shops, and soon educated labor will take the place of uneducated labor, and intelligent mechanics will displace those who refuse to learn more than they already know. But as matters now stand, with scarcely any facilities in our school system for even the most elementary technical training, few boys who leave the higher grades of our schools have any disposition to enter a workshop as apprentices; not because they have no mechanical genius or capacity for artisanship (for oftentimes their bent of mind is more in the direction of such pursuits than otherwise), but because their education has been such as to prejudice them against pursuits requiring manual labor, and to predispose them towards some other sphere of activity which they look upon as more dignified, and as giving them a higher social standing."

The same view is expressed in the following brief pargraphs from the report made by Messrs. Sluys and Van Kalken to the Belgian Minister of Public Instruction:

"We insist upon the importance of this principle because in many civilized countries many children of workmen and of peasants show a strong tendency to despise manual labor, aspire to abandon the condition of their parents, and to embrace occupations which they consider far superior, such as those of employés in commercial houses or in public offices.

"By organizing a serious teaching of manual work in the school of the people, and by excluding severely from the series of occupations those which have no other aim than the gratification of taste or luxury, these children will be inspired with a respect and taste for the useful occupations which their parents followed.

"We think that the principle above expressed should be applied even in schools attended by children of well-to-do families. They have only too much occasion, in the condition in which they live, to employ themselves with trifling things, and to attach to them an importance which they do not rightfully merit. By requiring them to perform labors really useful, we should counteract, to some extent, the false effects of a domestic education often badly directed."

We are far from endorsing the possible suggestion in the above extract that a child should necessarily follow a given occupation merely because his parents have done so; but, if it is not a dishonorable one, respect for them forbids that he should be deliberately taught to look upon it with contempt or dislike. He should be so taught in the school that he will not despise labor, however humble, but will merely be helped in his choice of the *kind* of labor for which he is best fitted. This being done, we may safely trust to the influence of surroundings and of natural aptitudes to determine his career in the direction most conducive to his own welfare and that of society.

Not less important than the influence of manual training and industrial education upon the child himself, is its bearing upon the progress of industry. We cannot do better upon this point than to quote the following additional paragraphs from Dr. Barnard's report [p. 15]:

"In short, it is the testimony of all who have studied the subject, that technical schools, when rightly directed, gives wonderful impulses to industrial pursuits by promoting scientific investigation and methods. Although, at first, this influence affects only those who attend the classes, it soon makes itself felt throughout the entire body of workmen of the community to which the school belongs, and the increased interest in scientific subjects on the part of employés, thus developed, in turn reacts to the pecuniary advantage of their employers; because mechanics who have been trained in the scientific principles that underlie their handicrafts are thereby enabled to understand the technical publications affecting their trades, and to utilize new inventions and improved methods of work; while men uneducated in the rudiments of science ignore such sources of knowledge, and, quite naturally, oppose all improvements as innovations calculated to work injury to the laboring classes. Cultivate a laboring man's intelligence to a point where it recognizes improvements and comprehends their nature; his opposition ceases, and he will himself likely invent improved processes, which will inure to his employer's benefit.

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"Technical education has been the means of attracting capital not only to specific localities, but to countries. Indisputable evidence of this is found in Switzerland, and notably in Zurich, the manufacturing town above cited. For years a technical school has been conducted in this town at government expense, and when recently the Federal Council was disposed to lessen the usual grant for its support, the manufacturers showed, by undeniable evidence, that this single institution had in a few years been the means of bringing capital to the country to the extent of millions of pounds sterling."

Judge MacArthur, in his valuable book on "Education in its Relation to Industry," strongly supports this view:

"To compete successfully with foreign work, we must have a class of artisians as highly cultivated in workmanship as those we import from over the sea, and this skill can be acquired only by practice in their respective handicrafts. It is true that with us applied science and mechanical powers have superseded, in a great measure, the burden of heavy labor; but the quick eye, the expert hand and the acute taste can never be dispensed with in the manual processes of the arts and manufactures. To meet this imperative demand for first-class workmen, without submitting to the exactions and competition of foreign work, we must educate the constructive ability of our youth during the period of life which is now devoted to study alone. We have developed, in a high degree, the art of manufacture, but we are nearly without any American artisans in the trades connected with design, and are consequently deprived of the acknowledged sharpness and ingenuity of our countrymen in helping on American industries. This wide and remunerative field of labor is left to be occupied by partly educated and skilled foreigners. We have excellent schools for all sorts of instruction in the essentials of mathematics, history, literature and philosophy, but we fit nobody with either skill or knowledge in any particular habit of industry.

"The period seems to have arrived when institutions of industrial science and education can no longer be postponed in our country, and when they must be tried on as extensive a scale as those witnessed abroad. There seems no reason why the educational system should not be adapted to the tradesmen, the artisan and the manufacturer, as well as to the more pedantic professions, in which men are so thoroughly trained. The reform of our taste has commenced by the purifying influence which proceeds from, and which will gradually make its way through, the community from the universal teaching of drawing. An appeal must now be made in behalf of teaching the processes of production, as well as the principles which shall guide the work. The use of tools and machinery does not come by intuition, and industrial knowledge ought to include instruction in their use."

It is true that many employers still prefer workmen who have been trained as apprentices from their earliest years; but it is also true that the system of trade apprenticeship is practically obsolete through-

out the civilized world. Every highly organized industrial nation has come to recognize the fact that in can excel in the sharp race of modern competition, only by maintaining superior skill, economy and efficiency in its productive processes; and the conclusion is fast gaining acceptance that this result can only be secured by the better training of its workmen and the closer application of scientific principles and methods. The margin of profit in all established lines of industry is so small, that the producer who wishes to attract and hold the market, must do it either by underselling his competitors with the same article, through superior cheapness of production, or by introducing into his product some element of form or substance which others do not possess. This consideration is so obvious as not to require extended argument; but abundant testimony relating to it will be found in the appendix, in the extracts from the reports of the British commission.

One of the most striking facts in the present industrial condition of nearly every European country, as well as the United States and several countries in South America, is the extensive employment of Germans in all positions requiring scientific and technical knowledge. It is, in a scientific and industrial sense, a veritable "Teutonic invasion," and it is the direct result of the long-continued, intelligent and unremitting efforts of the German governments to provide for their people the best possible technical instruction. But their general school system is still defective on the practical side. The English, the French and the people of the United States excel the Germans in mental aptitude and in adaptability to the varying requirements of circumstances. The educated German works on well considered and secure lines; but he works by routine. The Frenchman, the Englishman and the American follow a less rigorous method, but work with more facility, and adopt changes more easily. An interesting statement on this point is given in a private letter to a member of the Commission, from a gentlemen who has resided several years in Europe, and has been a close observer of social and economic movements:

"BONN, *November 18, 1888.*

"Yesterday I went with one of the professors of national economy, with six or eight of his students, to visit a large establishment for the manufacture of pottery, employing 700 hands, and sending its wares in large quantities to both England and the United States. Its clays are brought from England and a large part of its wares are sent back to England—a nut for English free trade to crack by and by. The foreman or superintendent, who was sent by the proprietor to accompany our party, is an Englishman, and he surprised me with the statement that the British technical education is better than the German, and that the German potteries and porcelain manufacturers send to England for superintendents. I told him of the different opinion prevailing in London last winter. He replied he knew the British opinion, but said it is a mistake. The German polytechnic schools teach science, and their men excel the English in science, but they get no practice, and when they finish their studies at 19 or 20 years of age they will not work, and are too old to begin at the bottom and learn the practice thoroughly. The English student is a workman

who labors through the day and goes to the night classes of South Kensington or the City of London College or elsewhere, and masters the science at the same time he is learning the art. So when a practical superintendent is wanted the Englishman is sent for. Such he said was his own history. Whether it is true in other than pottery manufactures he did not say. The thing is worth considering. Per contra, the proprietor told us that the training of the boys and girls in drawing, etc., in the Volkes-schule here gave him much cheaper decorators, of whom he employs 200, than the English get. Most of the English decorators and porcelain painters are artists requiring high wages; in this establishment we saw many boys and girls of 14 and 15 at work painting or filling out with colors the printed designs. So Germany is still ahead in cheapness and undersells England in the English markets."

No one will question that American youth should receive in the public schools the best preparation for life which the state of knowledge allows. The unprecedented growth of our population; its rapid concentration in towns and cities; the profound changes in our social and industrial condition which are going on, and the enormously increased facilities for intercourse with other nations have laid upon the present generation—will lay upon each succeeding generation—burdens and responsibilities which were undreamed of fifty years ago. We are participants in a world-wide competition, and if our youth are to fill the measure of their duty and of their privilege, they must be equipped with every resource which education can supply. We may quote, without necessarily approving every expression, the following paragraph from a speech delivered in the United States House of Representatives, by the Hon. D. J. Morrell, of this State!

"The American workingman must live in a house, not a hut; he must wear decent clothes and eat wholesome and nourishing food. He is an integral part of the municipality, the State and the nation; subject to no fetters of class or caste; neither pauper nor peasant, nor serf, but a free American citizen. He has the ballot, and if it were possible, it would be dangerous to degrade him. The country stands pledged to give him education, political power and a higher form of life than foreign nations accord to their laborers, and he must be sustained by higher rates of wages than those of Europe. Our industries operated by American citizens, must be freed from foreign interference and organize into a distinct American system, which will exact some temporary sacrifices, but result in general prosperity and true national independence. In maintaining diversified industries we utilize every talent, provide a field for every capacity, and bind together the whole people in mutual dependence and support, assuring the strength and security of our republic."

Mr. Mather, of Manchester, who has been already quoted, makes the following pertinent suggestions bearing upon this point:

"As you know, your country does possess already a considerable number of very remarkable technical schools, which certainly are not surpassed by any school in Europe. They are schools, however, that are not available for the working classes, as those of Germany, France and Switzerland, and what little we have done in England. They belong to a higher rank in society, and therefore you have not felt them in your ordinary life. But for the training of skilful managers, foremen, and even

proprietors of large industries, about a dozen of the schools and colleges of this country are not surpassed by anything in Europe.

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"You seem to have a wide-spread—almost universal—opportunity for all the people here to get a technical and scientific education. All that you want is a shuffling of the cards to alter the curricula of the various institutions. There is more spent in this country for education than in any other country in the world—both I think by private beneficent individuals who have left money for certain colleges and universities, and, of course, by the generosity of your towns and cities in the public school system—that is a fact of world-wide notoriety. I do not think the working classes here have anything at all to complain of in regard to education, except that it does not have a strong enough and close enough relation to the industries which the working classes pursue."

The only real question is, whether manual training as introduced in so many places, is a sure means of obtaining the desired result. On this point opinions will naturally differ; but we are compelled to say that, having approached the consideration of the subject with the single purpose of ascertaining and stating "the truth, the whole truth, and nothing but the truth," the facts of experience and the testimony of thoughtful observers which have come under our notice point with almost absolute unanimity in one direction. We are persuaded that manual training in the public schools supplies a deeply felt need; that its processes have become well enough established to enable any community to enter upon it intelligently and successfully; that it involves no great expense or difficulty; that it should be introduced as rapidly as possible into every grade, beginning with kindergarten work; and that it promises the richest results to the great body of our people, physically, intellectually and morally.

It will not diminish the vigor and efficiency of our public schools as they now exist, but will increase both; it will not divert our children away from industrial pursuits, but direct them towards them; it will not result in the teaching of trades by the public schools, but will train the body of youth intellectually prepared to enter upon all trades; it will not interfere with the highest intellectual training of those who are designed for professional pursuits, but will give a body of common knowledge and common skill which will be of incalculable value to the students of all professions; it will not lower the standard of instruction, but will elevate it; and, apart from its influence on the schools, it will help to give dignity and efficiency to every form of useful labor. We cannot better conclude our observations upon this point than by the following quotation from a valuable report upon this subject issued by Commissioner Eaton, lately of the United States Bureau of Education:

"The manufacturer is aided by industrial education through the improvement of his products. His success depends upon the demand for his goods at reasonable prices. This demand is regulated by the needs of customers. They ask for durability of material, attractiveness of design and excellence of workmanship in whatever they purchase for permanent use. Manufacturers' business improves as they become possessed of these and similar qualities, which can be economically secured only by the application of technical knowledge. Durability arises from excellence

of raw material, and is retained by the selection of the right processes by which to convert it into the state in which it finally appears. The quality of raw material is not unfrequently to be determined by chemical tests, and many of the processes of its manufacture are regulated by chemical principles. The science which guides in the determination of these processes must be the one which will lead to their improvement and perfection. Hence courses in chemistry are established in our polytechnic schools, as well as in colleges of agriculture (to which science chemistry makes liberal contribution), and in schools of mining and metallurgy. For a similar purpose engineers are taught to determine the strength of materials used in building railroads and bridges, houses and machines. Investigations in the domain of physics and chemistry have frequently taught the skilful application of new and serviceable agents to the production of labor. Men thus taught have laid out our railways, opened our mines, started and improved our manufactories and built our houses. They have aided in increasing our industries 35 per cent. in the last decade and in compelling an English confession that 'the United States will probably pass us in the ensuing decade' in the value of her industries.

"The elevation of the working classes is an inevitable result of educating them in industries. The direct effect upon the intellect is great and beneficial. The immediate moral influence is of the best. A manly feeling is awakened and kept alive by the consciousness of power and skill to do. An incentive to frugality and enterprise is set forth. It has been laid down as a rule by Prof. Edward Atkinson that—

"'Other things being equal, high wages, coupled with low cost, are the necessary result of the most intelligent application of machinery by the arts, provided the education of the operative keeps pace with the improvement of the machinery.'

"Industrial education dignifies labor as well as opens doors to its skilful and remunerative performance. If labor has a noble end and purpose, if it employs intellect, if it abundantly rewards its servants, then it is worthy to be crowned."

Success of the System.

We have already said, but we beg leave to repeat, that the views here presented by the Commission are such—and such only—as have been sustained by ample experience. Wherever an attempt has been made to introduce manual training into the public schools—whether in a special school, as in Philadelphia, or in the general system as in New York, New Haven and many other places,—whether it has been supported by appropriations from the municipal treasury, or by private contributions of public-spirited citizens, the result has been the same: teachers, pupils and parents vie with each other in their testimony to its healthful and beneficial influence. We believe that no instance can be found where the work, having once been begun by the proper authorities, has been allowed to stop or to diminish; but, on the contrary, in nearly if not quite every case where even a small and tentative beginning has been made, with the least possible expenditure of money, the work has been increased with the growing approval and confidence of the entire community. Perhaps the most striking instance of the rapid extension of the system in the face of doubt and hesitancy at the beginning, but in obedience to the growing demands of public sentiment, is that of New York city. In accordance with the recommendations of a committee, the Board of Education provided for the beginning of such training in a few of the grammar and primary schools of the city, in February, 1888. The

interest of the pupils and of parents in the work increased so rapidly that it was extended, on the application of the local school trustees, into a large additional number of schools, until, in November of the same year, nearly ten thousand children were receiving that form of instruction.

Manual Training in Rural Schools.

Thus far manual training has been introduced only in certain localities. No State has adopted a general system, applicable to all alike, and it is obvious that the difficulties in the way of such a measure are very serious. The requirements of town schools and city schools do not greatly differ; but between these and the rural school the distance is very great. It is sometimes said that the boys and girls in the country schools have less need of this kind of instruction than those of town or city schools, for the reason that their daily employments about the farm or in the household give them a readiness in performing common tasks which the less favored city boy seldom acquires: but while there is truth in this observation, it is also true that the range of such employments is comparatively limited, and that they are not generally so conducted as to cultivate habits of precision and carefulness in the performance of them. Systematic manual training would give to such boys and girls a variety of exercises and of skills, which only the favored few can otherwise acquire. We believe that the natural aptitude for such exercises, fostered as it is by their circumstances, would produce even better practical results there than in schools of the other kind. The case of Sweden furnishes most interesting evidence of the ease and success with which such a system can be introduced into rural schools when it is once undertaken, and the manifold advantages resulting from it. But whatever may be the fact upon this point, it requires but a moment's reflection to see that the most serious obstacle to the introduction of such a system throughout the entire system of schools, is, at present, the lack of a sufficient number of properly trained teachers. The teacher who has been prepared to give instruction in intellectual studies only, is obviously unable to give instruction in the principles and processes of manual exercises of which he or she has no knowledge. On the other hand the most skilful workman, unless he has been specially trained for the purpose, is likely to lack in the teaching capacity, and for this reason is unprepared to follow the systematic and progressive course of training upon which the educational value of the exercises depends.

The Need of Teachers.

The Commission has no doubt therefore, that while it is entirely feasible to introduce manual training into the schools of our more favorable localities at once, it cannot be generally done, except under special circumstances, until the body of common school teachers in the

State have received a special training for that purpose. For this reason we attach the very highest importance to the normal schools of this State with reference to this work. The experience of Sweden and of France show conclusively that a body of teachers can be very rapidly formed. Manual training is now given in nearly eight hundred schools in Sweden, and more than one hundred schools in the city of Paris alone have work shops attached. Normal schools and special courses have been established for the purpose of training teachers in the work. In Sweden it is found that an ordinary teacher, by spending six weeks in one year and five weeks in the following year in a special course of manual training, can acquire all that is necessary for teaching its elements successfully.

The Normal Schools.

The normal schools of this State are, under the provisions of the laws regulating and controlling them, an essential part of the public school system. The primary object of their organization was to furnish professionally qualified teachers for the public schools throughout the State. They are to be responsive to the necessities of the public schools, and as far as possible these necessities should be anticipated. A fair and liberal interpretation of the laws regulating the system of normal schools in the State, clearly authorizes and requires them to enter upon the work of preparing teachers for manual training in the public schools, whenever they shall become a part of the curriculum. To render these laws effective in the hands of those charged with the conduct of the schools requires only a moderate additional expenditure which it is hoped the Commonwealth will now provide for. We believe it would be easy and highly desirable to introduce this branch of preparation into every normal school of the State within the coming year, and that the beginning thus made in the preparation of a teaching body, would result in the very rapid diffusion of the system throughout the State.

Manual Training in Reformatories.

There is another bearing of the system of manual training as a part of education, which seems to the Commission worthy of the most serious consideration, namely, its relation to our reformatory institutions for youth of both sexes.

The rapid increase of juvenile vice and crime in recent years has been very generally noticed and deplored. This evil, with its attendant evil, pauperism, is chiefly confined to our cities and larger towns. Here great numbers of children, especially those of poor families, are growing up in idleness and in ignorance of all manual occupations. They leave school at an early age, and complete their education on the street. There is nothing for them to do, and hence they do nothing. Criminal statistics show what the result is. Said a

New York supreme judge not long since: "There is a large class—I was about to say a majority—of the population of New York city and Brooklyn, who just live, and with whom the rearing of two more children means inevitably a boy for the penitentiary and a girl for the brothel." These children are brought up in an atmosphere of vice and immorality, take up with crime at an early age, and so become the enemies of society and an expense to the State. The amount of pernicious literature devoured by them, is conclusive proof that illiteracy can no longer be blamed for juvenile delinquencies.

When it is remembered that at this time two-fifths of the population of the State reside in towns, the importance of this subject will be appreciated. In the opinion of the Commission, it is high time for the State to exert itself to find a check for this condition of things. To us there appears two remedies at hand: The first is manual training for the public schools; the second State Handicraft schools for all pauper, vagrant and homeless children. What such schools should be is well described in the reports of the inspectors of the Eastern Penitentiary, extracts from which accompany this report. They should be out in the open country, where each school should have attached to it a suitable amount of farm land. The buildings should be comfortable and commodious, properly fitted up and equipped for teaching useful handiwork, in addition to the branches of an ordinary English education. During the seasons of planting and harvesting, the boys should be engaged in the fields practically learning the art of tilling the soil While it is not to be expected that these schools would be self-supporting, the expense to the Commonwealth if they were prudently managed, would not be large, after the first outlay for grounds and buildings. It should be distinctly understood, also, that they should be in no sense penal institutions; not even reformatories, but homes for the homeless, friendless and neglected; and the inmates should have the benefit, as far as judicious expenditure, watchful oversight, and unrelaxing effort could secure it, of the same educational course of manual training in connection with the common English studies as we advocate for the public schools.

This State has now two juvenile reformatories. the House of Refuge in Philadelphia, and the Pennsylvania Reform School at Morganza, both of which have been visited by members of the Commission. They are both excellent in their character. The former being in a large city, on a small plot of ground, and surrounded by high walls, cannot do all that should be done for the inmates of a reformatory. The latter is admirably located and well equipped to keep the youth committed to its care usefully and profitably employed. We are clearly convinced, however, that there should be more manual training. The inmates of these schools should, above all others, be taught the value of manual skill. The class of people to which they belong look upon labor as drudgery. They see in it nothing but brute force,

and so despise it and all who engage in it. Manual instruction of the proper kind, judiciously imparted, will go far toward correcting these erroneous views. The work now done is mostly for revenue, and is considered by the inmates as a kind of penal service to be endured while in the institution, but to be dropped forever when they leave it. We recommend, therefore, that the curriculum of instruction be somewhat altered and enlarged. Some things might be dropped and others should be added. The inmates should contribute by their labor to the support of the establishment, but we should so adjust the working machinery that they would at the same time "earn and learn." The State would thus, as far as possible, help to break down the barriers which separate them from the youth of more favored circumstances, and open to them the hope of an honorable and self-supporting career, when once more thrown upon their own responsibility.

Manual Training for Young Women.

It will be observed that we have not spoken, except incidentally, of manual training for girls and young women, This omission has not arisen from any failure to appreciate that branch of the subject; but, in part, because some general lines of mechanical training have been found as well adapted to girls as to boys, and therefore required no separate treatment, and in part because we have thought it desirable to give more special attention to the subject than could be done in the body of the report, by gathering in the appendix such statements of fact and opinion as its importance requires.

How to be Supported.

With reference to the question whether manual training in its several grades, should be supported by State or local action, or by both, an experience of more than fifty years in this Commonwealth has shown that State and municipal authority have concurrently and harmoniously aided in the support and encouragement of the public school system, with results of the most gratifying character. A departure from this rule of action, would be experimental, and, as manual training as we understand it should be judiciously introduced into and made a part of the common school curriculum, wherever and whenever desired by the people, and voiced by them through the boards of directors, or controllers of public schools, our judgment is, that any increase of cost or expense resulting from its incorporation or introduction and maintenance in the public schools, should be borne by the State and local authorities jointly.

The Kindergarten.

Another branch of the subject which also might have been very properly treated at length is the course of training in primary schools commonly known as Kindergarten work. So much has been written upon this subject, however; so much intelligent labor has been de-

voted to the establishment and extension of it; its principles and methods are so well understood, that we have not felt called upon to give it particular notice. But we desire to say that, in our judgment, no system of manual training for graded schools would be complete which did not begin with the Kindergarten exercises in the lower grades, proceeding by steps so graduated that the later exercises, more distinctly known as manual training, should be the continuation and completion of the earlier.

Conclusion and Recommendations.

If, in presenting this subject to the Legislature, we shall seem to have spoken strongly, it is because we are strongly convinced. We believe the time has come when this step forward in the development of our public school system ought to be taken. It is demanded by public opinion, it is easily within reach, it is full of promise for the future of the Commonwealth. It would be unwise, however, to anticipate that a change so thoroughgoing and far reaching as the one we advocate could be adopted as a whole immediately, or without producing more or less friction. Old ideas and fixed customs will naturally oppose it. Its advocates and friends will not unnaturally entertain extravagant expectations as to what may be accomplished by it. It should be remembered, however, by friends and opponents alike, that the present movements in this direction are largely tentative, and we must expect that any system now adopted will be modified in its details as the result of increased experience. Such is the fate of all important public measures. We are solicitous only that the foundation shall be rightly laid in accordance with sound principles. This being secured, we can anticipate without concern any changes that time and experience and reflection may suggest; but these considerations should not be allowed to prevent the introduction now of such forms of training as have proved easy to carry on and fruitful of good results.

We beg leave, finally, to submit the following recommendations:

1. That provision be made for the introduction of manual training into each State normal school, with a prescribed course of wood work for all students, iron work for young men, and sewing and cooking for young women, such courses to be subject to modification from time to time under proper authority, and to include an amount of wood work not exceeding what on an average could be accomplished in a single course of twelve weeks (or in two courses of six weeks each), if the work were so arranged as to give the principal portion of the time to this course of exercises; the amount of iron work to be left optional with each institution. The work should be accompanied, at every step, with a progressive course in drawing.

2. That an appropriation of five thousand dollars be made to each State normal school for the establishment of the proper plant, includ-

ing, building, tools, equipment, etc., and a further sum of two thousand dollars annually for mainteance.

3. That after April, 1890, no certificate or diploma be granted by a normal school to any pupil or graduate who shall not have completed at least the equivalent or a six weeks' course in wood work, as already mentioned.

4. That for the purpose of providing facilities for pursuing this course of training to teachers already employed, and who may wish to acquire it, provision be made for the maintenance at present of a short summer course in wood work and iron work at the State College where such instruction has been maintained for several years.

4. That the State make a moderate annual appropriation, to be given on a uniform basis to such districts as shall undertake the establishment of manual training in or in connection with their public schools, with specific provision, however, that such funds, whether provided by the State or the district, shall not be used for the teaching of specific trades.

6. That provision be made for the introduction of drawing as a required study in every school in the State, at the earliest possible day.

7. That the law require every district in its subsequent erection or arrangement of buildings for school purposes, to make suitable provision for a room or rooms to be used for the purposes of manual training.

8. That provision be made or authorized for the grouping of rural schools, for the purposes of manual training, in such a way that, either the scholars from schools included in each group may go in sections from each school to some one conveniently located, there to receive instruction in manual training, or that a special instructor in manual training may be appointed, whose time shall be assigned to each school in turn.

9. That for the purpose of securing direct encouragement, oversight, guidance and inspection of all such work in the State, a special Deputy Superintendent of Public Instruction be appointed in the manner now provided by law, with a sufficient salary to secure service of the highest order, who shall be assigned by the Superintendent of Public Instruction to special duty as inspector of manual training.

10. That provision be made for the immediate introduction of manual training, arranged upon an educational method and for educational ends, in connection with a prescribed course of elementary studies, into the reformatory institutions provided by the State for youth of both sexes; but that in such cases no attempt be made to teach specific trades, except so far as such trades may be necessarily carried on for the purpose of supplying articles needed for consumption in the institutions themselves.

11. If the Commission may venture to suggest a recommendation upon a subject not intrusted to it by the resolution under which it

was appointed, we should respectfully but most earnestly recommend that any change which may be made in the provision for the maintenance of the soldiers' orphan schools, shall require the introduction of manual training, at least in wood-work for boys and sewing and cooking for girls, as an essential part of the course of instruction.

For illustrative material forming a small part of that upon which the conclusions of the Commission are based, reference is made to the following "Accompanying Papers" and appendices.

Respectfully submitted.

GEO. W. ATHERTON,
ADAM H. FETTEROLF,
NATHAN C. SCHAEFFER
GEORGE J. LUCKEY,
THEO. W. BEAN.

ACCOMPANYING PAPERS.

[The papers presented under this head were prepared for the Commission by individual members as material to aid in reaching conclusions.]

A. and B.

Memoranda by COL. THEO. W. BEAN.

A—THE PRESENT SCHOOL LAW—MANUAL TRAINING MAY BE INTRODUCED IN THE PUBLIC SCHOOLS.

With reference to the question "How far manual training can be incorporated into the present public school system in Pennsylvania, and what, if any, changes of law are necessary or desirable to that end," the following observations are submitted:

Two questions are here proposed: *a.* Can manual training be incorporated into the public school system in Pennsylvania? *b.* What, if any, changes of law are necessary to authorize the introduction of manual training as a branch of learning in the public schools of the State?

The Constitution of 1874 contains no provisions prohibiting manual training from being taught in the public schools of the State. The language used is, "The General Assembly shall provide for the maintenance and support of a thorough and efficient system of public schools, wherein all the children of this Commonwealth above the age of six years shall be educated, and shall appropriate at least one million dollars each year for that purpose." Under this liberal provision, the public schools of the State shall be made "thorough and efficient," by such legislation as shall be deemed necessary, without any restrictive clause or proviso, and it is made mandatory upon the Legislature to appropriate "at least one million dollars each year" for the maintenance and support of the system. An examination of the several acts of Assembly of the Commonwealth upon the subject of common, or public, schools, fails to disclose any statutory provisions prohibiting the incorporation of manual training into the public school system of the State.

(The act of 1854 provides that "A system of common school education be, and the same is hereby deemed, held and taken to be adopted according to the provisions of this act," etc., and section 23 of said act provides, that the directors "shall direct what branches of learning shall be taught in each school, and what books shall be used, agreeably to the provisions of the 25th and 38th sections," of the same act. The 25th section provides that the directors shall establish a sufficient number of common schools for the education of every individual above

the age of five (now six) years, and under twenty-one years of age, and the 38th section provides that "county superintendents shall see that in every district there shall be taught orthography, reading, English grammar, geography and arithmetic, as well as such other branches (of learning) as the board of directors or controllers may require." Here we have the board of directors or controllers vested with the power to "direct what branches of learning shall be taught" in the schools, and the superintendents empowered to see that certain branches of learning named in the law are taught, as well as such "other branches (of learning) as the directors may require.")

The Constitution provides that all the children of the Commonwealth over six years shall be *educated*, and the governing acts of Assembly declare that "the school directors shall direct 'what *branches* of *learning*' shall be taught in each school."

State Constitutions receive a broad and liberal interpretation in courts of law. Therefore, I assume that all that is comprehended in the words "branches of learning," as found in the statutes referred to, is taken to be within the meaning of the word "educated" as used in the Constitution.

The first section of the act of 1854 provides for a "*System* of *Common School Education.*" The act does not define what that system shall be. It provides for a certain minimum of studies, and then vests the school directors with discretionary power to enlarge or vary the curriculum, giving scope and flexibility to the system.

We believe the legislative mind studiously and advisedly chose the language in the act, and intentionally used the words "*branches* of *learning*," as distinguished from *education.* Under a fair construction of the act, full force and effect must be given to this language.

Webster defines the word *learn* as follows: "to acquire *skill* in anything. To gain by practice a *faculty* of *performing*."

And *learning*, (1). "The knowledge of principles or facts received by instruction or study. Acquired knowledge or ideas in any branch of science or literature." (2). "Knowledge acquired by experience, experiment or observation."

Considering the act of 1854, we believe its provisions comprehend and authorize the introduction of manual training in the public schools of the State as a "branch of learning."

Parent, guardian and pupil have the right to demand and receive as an equivalent for the school tax they pay all the advantages of the "branches of learning" now directed to be taught in the public schools. These schools are intended primarily to benefit the pupil, and indirectly the State, in the betterment of its citizens. Therefore, if the board of directors believe that instruction in drawing, cutting and making garments, knitting, plain and ornamental needlework, baking, broiling, stewing and roasting, with charts to study the anatomy of food animals, and applied chemistry in culinary art for girls,

drawing and the use of hand tools for boys, in wood, iron, leather and in the use of machinery driven by water, steam or electricity, with instructions in wood carving and molding in plastic substances for boys and girls, will serve to give to the pupils "knowledge of principles or facts," or enable them to acquire knowledge by "experience, experiment or observation," or to "acquire skill in anything," or to "gain by practice a *faculty* of *performing*," then these "*branches* of *learning*" come within the word "educated," as used in the Constitution, and which is defined by Webster as "comprehending all that series of instruction and discipline which is intended to enlighten the understanding, correct the temper, and form the manners and habits of youth, and *fit them for usefulness in their future stations*."

Primary instruction in manual training is as essential to a subsequent scientific course of education as the trained eye and artful hand are to the accomplished instrumental musician. The performer reads the notes of harmony as a mental exercise and accompanies this intellectual process with a corresponding employment of the skilfully trained hands, feet, or it may be of the vocal organs.

The students of technical institutions and those taking the "scientific or technical course" at the many colleges and academical institutions of the country are all making manual training a direct and contributory agency in the completeness of their education.

The cadets of the United States Military Academy at West Point, New York, and of the United States Naval Academy, at Annapolis, Maryland, are trained in the manual of arms, gunnery, defensive fieldworks, horsemanship, constructive naval architecture, steam engineering and seamanship, as a part of their education for the profession of arms; if manual training is comprehended in the education of the musician, the civil and mechanical engineer, the officers of the army and the navy, it follows that it may advantageously be made a part of the system of education provided for the children in the public schools of the State, who are certain to become our future artisans, farmers, merchants, manufacturers and those who are to preside over and measurably control the homes and households of the Commonwealth.

The popular sense in which words are used in statutes must be given due weight in their interpretation by the lay, as well as the judicial mind.

"Words are generally to be understood in their usual and most known signification, not so much regarding the proprieties of grammar, as their general and popular use." When discretionary powers are vested in public officers by the Legislature, the judiciary will not interfere with the exercise of them. The power of directing "what branches of learning" shall be taught in each shool is a discretionary power.

Taking the popular sense of manual training as a means of mental

training, as understood and expressed by educators and public writers on the subject, it is certainly comprehended in the words, "branches of learning" as used in the act of 1854, regulating public schools in this Commonwealth.

B—LEGISLATION IN OTHER STATES.

Very few of the States have as yet legislated on the subject of manual training, nearly all that has been done by towns and cities at the public expense having been done in accordance with the general authority conferred by law upon the local school authorities. The following, as far as ascertained, are the only important enactments now in force:

Massachusetts.

[Act of 1872.]

SECTION 1. In every town there shall be kept, for at least six months in each year, at the expense of said town, by a teacher or teachers of competent ability and good morals, a sufficient number of schools for the instruction of all the children who may legally attend public school therein, in orthography, reading, writing, English grammar, geography, arithmetic, drawing, the history of the United States and good behavior. Algebra, vocal music, agriculture, sewing, physiology, and hygiene shall be taught, by lectures or otherwise, in all the public schools in which the school committee deem it expedient.

* * * * * * * * * * * *

SECTION 7. Any town may, and every city and town having more than ten thousand inhabitats shall, annually make provision for giving free instruction in industrial or mechanical drawing to persons over fifteen years of age, in either day or evening schools, under the direction of the school committee.

SECTION 8. A town may establish and maintain one or more industrial schools, which shall be under the superintendence of the school committee, who shall employ the teachers, prescribe the arts, trades, and occupations to be taught therein, and have the general control and management thereof; but they shall not expend for any such school an amount exceeding the appropriation specifically made therefor, and shall not compel any scholar to study any trade, art, or occupation without the consent of his parent or guardian; and attendance upon such school shall not take the place of the attendance upon public schools required by law.

SECTION 9. A town may establish and maintain, upon shore or upon ships or other vessels, at the option of the school committee, one or more schools for training young men or boys in nautical duties; such school shall be subject to the provisions of the preceding section,

except that the school committee may excuse boys attending such nautical schools from attendance on other schools.

[Act of 1883.]

An act for the establishment and maintenance of evening schools.

Be it enacted, etc., as follows:

SECTION 1. Every town and city having ten thousand or more inhabitants shall establish and maintain, in addition to the schools required by law to be maintained therein, evening schools for the instruction of persons over twelve years of age in orthography, reading, writing, geography, arithmetic, drawing, the history of the United States and good behavior. Such other branches of learning may be taught in such schools as the school committee of the town shall deem expedient.

[Act of 1884.]

An act relating to instruction in the elementary use of hand tools in public schools.

Be it enacted, etc., as follows:

Section one of chapter forty-four of the public statutes, relating to the branches of instruction to be taught in public schools, is amended by striking out, in the eighth line, the words "and hygiene," and inserting instead the words "hygiene and the elementary use of hand tools," and in any city or town where such tools shall be introduced, they shall be purchased by the school committee, at the expense of such city or town, and loaned to such pupils as may be allowed to use them, free of charge; subject to such rules and regulations, as to care and custody, as the school committee may prescribe.

Approved March 10, 1884.

New Jersey.

An act providing for the establishment of schools for industrial education, approved March twenty-fourth, eighteen hundred and eighty-one.

WHEREAS, The establishment of well-conducted and liberally-supported schools for the training and education of pupils in industrial and mechanical pursuits must tend to supply a growing want in our community of skilled mechanics, artisans and agriculturists; and

Whereas, It is especially the duty of the State to afford good educational facilities to its youth in those technical studies, which are directly associated with the material prosperity of its people; therefore,

1. Whenever any board of education, school committee, or other like body, of any city, town or township in this State shall certify to the Governor that a sum of money not less than three thousand dollars, has been contributed by voluntary subscriptions of citizens, or

otherwise, as hereinafter authorized, for the establishment in any such city, town or township, of a school or schools for industrial education, it shall be the duty of the said Governor to cause to be drawn, by warrant of the comptroller, approved by himself, out of the income of the school fund,* an amount equal to that contributed by the particular locality as aforesaid for the said object; and when any such school or schools shall have been established in any locality as aforesaid, there shall be annually contributed by the State, in manner aforesaid, for the maintenance and support thereof, a sum of money equal to that contributed each year in said locality for such purpose: *Provided, however*, That the moneys contributed by the State, as aforesaid, to any locality, shall not exceed in any one year the sum of five thousand dollars.

2. All moneys raised and contributed as aforesaid shall be applied under the direction of a board of trustees, organized as hereinafter provided, to the establishment and support of schools for the training and education of pupils in industrial pursuits (including agriculture), so as to enable them to perfect themselves in the several branches of industry which require technical instruction.

3. Any city, town or township shall have power to appropriate and raise by tax for the support of any such schools therein, such sum of money as they may deem expedient and just.

4. There shall be a board of trustees of each of such schools, which shall consist of the Governor, *ex officio*, who shall be president thereof; two persons selected by the State Board of Education; two by citizens and associations contributing; two by the board of education, school committee or other like body of the locality where such school is established, and one by the common council, township committee or other governing body thereof, if such city, town or township shall contribute to the maintenance of such school; the said board of trustees shall have control of the buildings and grounds owned and used by such schools, the application of the funds for the support thereof, the regulation of the tuition fees, the appointment and removal of teachers, the power to prescribe the studies and exercises of the school and rules for its management, to grant certificates of graduation, to appoint some suitable person treasurer of the board, and to frame and modify at pleasure such by-laws as they may deem necessary for their own government; they shall report annually to the State and boards of education their own doings and the progress and condition of the schools.

5. The said trustees shall receive no compensation for their services, but the expenses necessarily incurred by them in the discharge of their duties shall be paid out of the income of the school fund * upon the approval of the Governor.

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* Act of April 4th, 1885.

An act for the promotion of industrial education, approved April twenty-eighth, eighteen hundred and eighty-seven.

1. Whenever, in any school district in this State, there shall have been raised by special school tax or by subscription, or both, a sum of money not less than one thousand dollars for the establishment in such district of a school or schools for industrial education, or for the purpose of adding industrial education to the course of study now pursued in the school or schools of such district, there shall be appropriated by the State, out of the income of the school fund, an amount equal to that appropriated by the district as aforesaid; and when such school or schools shall have been established in any district, or said industrial education has been introduced into the course of study in the school or schools of any district, there shall be appropriated by the State for the maintenance and support thereof a sum of money equal to that appropriated each year by the district for such purpose: *Provided*, That the moneys appropriated by the State as aforesaid to any school district shall not exceed in any one year the sum of five thousand dollars.

2. That the trustees of any district in this State receiving an appropriation under the provisions of this act shall annually, on or before the first day of September, making a special report to the Superintendent of Public Instruction of the progress of industrial education in such district and such other information in connection therewith as he may require.

An act for the promotion of manual training, approved February fifteenth, eighteen hundred and eighty-eight.

1. Whenever any board of school trustees or board of education of any school district in this State shall certify to the State Superintendent of Public Instruction that there has been raised by special district school tax, or by subscription, or both, a sum of money not less than five hundred dollars for the establishment in such district of a school or schools for manual training, or for the purpose of adding manual training to the course of study now pursued in the school or schools of such district, it shall be the duty of the said State Superintendent of Public Instruction, with the approval of the Governor, to draw his order on the Comptroller and in favor of said district for a sum equal to that contribution by said school district as aforesaid for said object; and when said school or schools shall have been established, or manual training shall have been added to the course of study in any district, there shall be annually contributed by the State, in manner aforesaid, for the maintenance thereof, a sum of money equal to that raised each year in said district for such purpose: *Provided*, That the course of manual training established or introduced under the provisions of this act shall be approved by the State Board of Education: *Provided further*, That the moneys appropriated by the State as afore-

said to any school district shall not exceed in any one year the sum of five thousand dollars, and that all payments made in pursuance of the provisions of this act shall be paid on the warrant of the Comptroller out of the income of the school fund.

2. The trustees of any school district in this State receiving an appropriation under the provisions of this act shall annually, on or before the first day of September, make a special report to the State Superintendent of Public Instruction, of the progress of manual training in such district, and give such other information in connection therewith as he may require.

An act to amend an act entitled "An act for the promotion of industrial education," approved April twenty-eighth, one thousand eight hundred and eighty seven. Approved March seventh, eighteen hundred and eighty eight.

1. Whenever in any school district there shall have been raised by special school tax or by subsccription, or both, a sum of money not less than five hundred dollars, for the establishment in such district of a school or schools for industrial education or for the purpose of adding industrial education to the course of study now pursued in the school or schools of such district, there shall be appropriated by the State, out of the income of the school fund, an amount equal to that appropriated by the district as aforesaid; and when such school or schools shall have been established in any district, or said industrial education has been introduced into the course of study in the school or schools of any district, there shall be appropriated by the State for the maintenance and support thereof a sum of money equal to that appropriated each year by the district for such purpose: *Provided*, That the moneys appropriated by the State as aforesaid to any school district shall not exceed in any one year the sum of five thousand dollars; the treasurer of the city or the collector of the township, as the case may be, shall be the legal custodian of any and all funds subscribed, allotted or raised for the purpose of carrying out the instruction contemplated by this act, and he shall keep a separate and distinct account thereof, apart from all other moneys in his custody whatsoever, and shall disburse the fund on the properly authenticated drafts of the trustees of the school district, or other persons or board having charge of public schools in such district; any unexpended balance to the credit of this fund in any township or city at the end of any fiscal year, shall not be covered into the treasury of the city or township, but shall be at the disposal of the school trustees or other persons or board having charge of public schools in the district, for the purpose of aiding industrial education in the succeeding year or years: *Provided*, That any such unexpended balance shall not be included in the report of the amount raised in

any succeeding year for the purpose of procuring State funds as above provided.

2. The trustees or other persons or board having charge of public schools of any district in [this] State receiving an appropriation under the provisions of this act shall annually, on or before the first day of September, make a special report to the Superintendent of Public Instruction of the progress of industral education in such district and such other information in connection therewith as he may require.

3. It shall be lawful for the trustees or other persons or board having charge of public schools of any school district to associate with themseves in the management of this fund a number of citizens, not exceeding ten, representing the donors, in case the sum or any part thereof necessary to obtain the State appropriation shall have been raised by private subscription.

New York.

An act was passed in 1888 entitled:

An act to authorize the establishment and maintenance of departments for industrial training and for teaching and illustrating the industrial manual arts in the public schools and normal schools of this State.

The people of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION 1. Boards of education of cities and villages, and of union free schools and trustees of public school districts, are hereby authorized and empowered to establish and maintain a department or departments in such schools for industral training and for teaching and illustrating the manual or industrial arts, and the principles underlying the same; and for that purpose they are respectively authorized to purchase and use such materials and apparatus, and to establish and maintain such shops, and to employ such instructor or instructors, in addition to the other teachers in said schools as in their judgment shall be deemed necessary or proper.

SECTION 2. Said boards of education and trustees, or other bodies now authorized by law to levy and raise taxes for school purposes, are authorized to levy and raise by taxation, in addition to any amount or amounts which they are now, respectively, in any city, village or district, authorized by law to raise for school purposes, and in the same manner, the necessary funds to establish and maintain such industrial departments as aforesaid: *Provided, however*, That trustees of school districts not organized as boards of education shall exercise no greater powers in these respects than they now possess by law, except upon a vote of such district.

SECTION 3. The State normal and training schools which are or here-

after may be established in this State, hereby are and shall be required to include in their courses of instruction the principles underlying the manual or industrial arts, and also the practical training in the same, to such an extent as the superintendent of public instruction may prescribe; and to such futher extent as the local boards respectively of said normal and training schools may prescribe.

SECTION. 4. This act shall take effect immediately.

Pennsylvania.

In this State an act was approved June 25, 1883, entitled,

An act authorizing central boards of education, in cities of the second class, to establish and maintain schools for instruction in the mechanic arts and kindred subjects.

SECTION 1. *Be it enacted, etc.*, That in every city of the second class the central board of education shall have power to establish and maintain one or more schools for the instruction of pupils in the useful branches of the mechanic arts and kindred subjects, to provide the necessary buildings, machinery, apparatus and materials, and to employ teachers and instructors therefor.

SECTION 2. Such schools shall be subject to such rules and regulations as may, from time to time, be prescribed by the said board; under said rules and regulations, they shall be open to the admission of such pupils, as are not enrolled, as well as of such as are enrolled, in the ordinary public schools of the city, and instruction may be gived therein in the evening, as well as the day.

SECTION 3. The course of instruction shall, from time to time, be prescribed by said board, and may include chemistry, mathematics, natural philosophy, and other branches appertaining to the mechanic arts.

At the last session of Congress a bill, which is still pending, was introduced in the Senate, entitled,

A bill to incorporate trustees of the National Industrial Institute in Washington, District of Columbia.

Be it enacted, etc., That [corporators named], and their associates and successors, be, and they are hereby, constituted a body politic and corporate in law, by the name and style of the "Trustees of the National Industrial Institute," and by that name may sue and be sued, plead and be impleaded, have perpetual succession, and shall and may take hold, manage, and dispose of, at all time, real and personal estate, and shall and may do and perform all other acts and things necessary or appropriate for the execution of the purposes, charities, and trusts for which the said corporation is created, and which are set forth in the second section of this act, and said corporation shall have

power to adopt and make such constitution, by-laws and regulations as may be appropriate and necessary for carrying out the purposes of said corporation, including provisions for the election of trustees and officers and agents of the corporation, filling of vacancies occurring in such offices and agencies, the taking, holding and management of the property of the corporation, and the sale and conveyance thereof, when necessary, for the purposes of such corporation, and the transaction of all other business appropriate and necessary for the purposes of such incorporation, with power to adopt and use a common seal for such corporation, and the same to alter at pleasure.

SECTION 2. That the object, purposes and powers of said corporation shall be, and the same are hereby, limited to providing teachers of industrial branches of education to the common schools throughout the United States, including the District of Columbia and the Territories, by the establishment of a central normal school in the city of Washington, in the said district, for the purpose of preparing and educating persons of both sexes as teacher aforesaid; and for such purposes the said corporation shall have power to take, hold, use and enjoy all such real and personal property, endowments and contributions, whether by devise, gift or otherwise, as may be appropriated for the establishment, maintenance and success of said institution, and also to acquire, take, hold, use, occupy, manage and own, either in fee-simple or by lease or otherwise, such real estate in the said District, not exceeding one million dollars, to be held, used, occupied and enjoyed for the purposes aforesaid, and for the residence, use and occupancy of the proper and necessary officers, employés and agents of such corporation: *Provided*, That the property, whether real or personal, owned by the said corporation, and used exclusively for the purposes of said organization, shall be exempt from taxation.

C.

Memoranda selected by DR. A. H. FETTEROLF.

MANUAL TRAINING IN REFORMATORY INSTITUTIONS.

Extracts from the Annual Reports of the Inspectors of the Eastern Penitentiary, Philadelphia.

(1880.)

Prevention of crime is as important a purpose of legislation as punishment. Trade schools, technical schools, in which the vicious, neglected or incorrigible youth should be placed for reform and training, are needed. They should not be characterized by any punitive feature. Personal restraint, coercion or incarceration should not be any part of the plan of their administration.

A tract of land, located away from large cities or communities, without other enclosure than that which bounds a farm; with small

houses, to accommodate not more than twenty inmates each, with shops and school-room, library and other necessary appendages, are only needed for such schools.

The youth sent there for instruction in trade. and training in mind and morals, should find in the attraction and advantages the strongest tie to constitute their custody.

Those who graduate with credit should have given to them as a reward of merit a diploma which would be sufficient evidence of capacity, trade knowledge, and good character to warrant their employment by railroad managers and other employers of skilled workmen, or in various industrial establishments. Truancy from such schools should not be unexpected, but when retaken and returned the absconding youth should be subjected to the most judicious mode of punishment. Experience would show such cases to be the exception rather than the general rule, attendant on the proper administration of the "public trade schools."

(1884.)

Trade schools are the most prominent of preventive agencies.

Establish methods of instruction in mechanical branches of industry in connection with approved means for mind culture, that pupils may have the advantage of the rudimental teaching to fit them for instruction in mechanical knowledge. Thus the capacities of the pupils are ascertained, and as they are developed the opportunity is promptly afforded for their proper training.

But it will be observed that a large number of the young evince criminal tendencies. The reasons are manifest. Their surroundings and associations; want of home government or parental care; idle, incorrigible, vicious by hereditary taint or family infelicities; vagrant and without care or oversight; such youth are directly liable to the temptations of mischief, and without any restraint they follow courses that end in crime. The houses of refuge or other prison reformatories are their first destination. For such as these, State trade schools should be established.

These institutions should be neither places of imprisonment nor forced restraint. These youth should be sent to these schools, and there so treated that the advantages presented would enlist their interest, excite their desire to learn, and be the means of securing their remaining as pupils till they had acquired a trade for their support in after life.

It is not to be expected all pupils would be so influenced, but if a majority were made useful, honest, capable mechanics, the State would be amply remunerated for the limited cost of such establishments. The first money outlay would be inconsiderable in amount. A farm of three hundred acres, with ten small frame houses, each to accommodate twenty boys, with neither locks, nor bars, nor bolts,

to restrain them, with shops to teach blacksmithing, horse shoeing, harness making, wagon making, and the like industries, should be the attractive and detaining influences.

Caring for the stock, agriculture, and out-door work would be a prominent part of the labor. Schools for the rudiments of education, for teaching the anatomy of animals, the first principles of chemistry, the use of metals, should be part of the course of instruction.

It is not intended to give more than in the merest outline, the character of such schools. Experience will make perfect what is now only a tentative description. It is the necessity of such schools that is now most important to be affirmed. Such an institution is worth a trial. The State can lose nothing. The cost of the care of these youths after they are criminals is far greater than the expense of such a plan to prevent them from being convicts.

(1885.)

The necessity of some well-considered plan by which the neglected class of children can be taught the rudiments of primary education, with those of mechanical handicraft knowledge, is too apparent to need further affirmation.

It cannot be denied that if one million and a quarter dollars are yearly raised by taxation in the city of Philadelphia for school purposes, some portion of this fund might wisely be expended in efforts to prevent crime in a class of scholars who need such teachings. The poor, neglected, ungoverned pupils, without home influence for good, subjected to neither parental oversight nor home influences, domestic attachments or family ties, might, out of this large yearly fund, be taught and trained by careful methods, at least to avoid the penitentiary, as the school in which their minority graduates into manhood.

Establish trade schools where this class can be instructed. Let there be neither bolts, bars, locks, nor forced restraint. Let these schools be a collection of family houses, in which a certain numbe of pupils are convened for all purposes except the teaching.

In each house the inmates are to sleep, eat, and pass their hours of rest. Each house is to be managed by the inmates—kept clean and made comfortable. Create a system of encouragement by rewards for a method of successful home life to be maintained by the inmates of these houses. So, too, with all the relations these pupils hold to the school.

Teach all the trades that are needed in every day life. Divide the pupils into classes as they show aptitudes, for blacksmiths, wheelwrights, harnessmakers, shoemakers, horse shoers, carpenters, and the like. Obtain two hundred acres of land; put a plain post and

rail fence to mark its boundaries. Teach the care of farm stock, farming, agriculture, the farm work; utilizing the labor for the benefit of the school.

Teach, in connection with this manual training, the knowledge that directly belongs to each branch. Fix certain hours for mental improvement, in conjunction with out-door lessons in "facts and things."

Create ties thus between the awakened interest of the pupils and their school home. If any argument is needed to emphasize these views, the foregoing facts are deemed sufficient, or at least of value in support of them.

Extract from the Annual Report of the Board of Public Charities.

(1887.)

There is much interest to every citizen of this great Commonwealth in the annual reports of the inspectors of this prison (Eastern Penitentiary). These reports are already before your Board, and it is not possible for us to enter into all the questions so ably discussed in them. But on one point we feel that we must express our hearty concurrence with the recommendations of the inspectors, viz: for the establishment of "trade schools, established by State authority for the reception of ungoverned, uncontrolled, derelict youth under twenty years of age." The inspectors add: "These institutions should be in no sense places of enforced detention. Neither is it to be understood that sentences by courts of law are to be necessary for reception into such schools. Judges and magistrates should be authorized by law to remit such persons to these schools, for care and instruction, as parents entrust their children to boarding schools, away from their homes." This recommendation so often and so earnestly repeated, is made from statistics whose results must attract serious attention from all thoughtful persons. For instance, from January 1, 1876, to December 31, 1886 (ten years), there were received into the Eastern Penitentiary from Philadelphia county, 678 convicts, 25 years of age and under, on their first conviction. Of these 678, 550 attended public school, 36 private school, and 92 never attended any school; 64 had trades by apprenticeship or by working at them, 614 had no knowledge in badicraft, and 526 were idle at time of arrest. During tne previous ten years, out of 1,160 convicts not older than 25 years of age, only 146 had never attended school, while 1,024 had no knowledge in handicraft, and 832 were idle at time of arrest. Well may the inspectors say that "these facts command earnest and thoughtful consideration," and the Legislature of our State can have no subject presented to it of higher importance. We invoke the aid of your Board in securing the adoption of a measure that cannot fail to be effectual in the prevention of crime.

CHARITY ORGANIZATION SOCIETY OF THE CITY OF NEW YORK,
GENERAL OFFICE, 21 UNIVERSITY PLACE, *June 23, 1888.*

MR. A. H. FETTEROLF, LL. D., *Girard College, Philadelphia, Pa.*

MY DEAR SIR: Replying to your inquiry of the 8th inst., asking my views as to "how far proper manual instruction or industrial training would go to relieve pauperism and crime in our large cities," I would premise that I have thought it necessary to take into account the mental and moral, as well as physical deterioration that results from lack of skilled ability in any department of labor.

Much of the existing pauperism is the result of a lack of that adaptability and versatility which manual dexterities promote, and which go far to enable the poor to meet and overcome their helplessness. I believe manual training to be the chief physical factor in cultivating these agencies, and so enabling the depressed to rise superior to their trammels, and in developing latent and unsuspected capabilities. It is my opinion that such training tends much to overcome the stigma attaching to manual labor; a condition that results in precipitating large numbers of those who are born with some opportunities for education, into despondency and penury.

The connection is so close between physical poverty and mental and spiritual poverty, in my mind, that I cannot disassociate them in replying to your question.

I believe that not far from forty per cent. of the pauperism, poverty and depression, which rapidly sinks into pauperism, is due to a lack of the resources and intelligence which result from a training which equips its recipients for all departments of manual work, without giving them technical education in any of them.

In this estimate I do not mean to include felonies, concerning which I do not feel competent to speak, but I would include all those petty crimes and vices which accompany depraved penury in a large city, and which may be included under the generic term "pauperism," which, like war, may be said to be "the sum of all villianies."

The nearer we come to giving a generation a well rounded education of the brain, the heart and the hands the better we shall prepare men, handicapped from birth with poverty in an over-crowded labor market, to rise above the lowest ranks of unskilled and insufficiently paid labor, and more particularly will we put them in a way not only of independence but often of rescue from ruin.

You may think I attach large importance to the agency of industrial training, but the education which strengthens the body and elevates the mind intellectually and morally, and gives man broader views of natural laws, unquestionably fits him better to cope with the disadvantages and disabilities of his position.

By far the larger part of the cases of poverty that come under my notice reveal a lack of character in some one particular, and, as John

Stuart Mill says of those who are acquiring industrial education, "they would acquire not only manual dexterity, but habits of order and regularity of the utmost use in after life, and which has more to do with the formation of character than any persons are aware of." I believe with Mr. Belfield, of Chicago, "that the number who, as paupers and criminals, subsist on the honest earnings of others is much larger than it would be if the youth of the country had been taught to earn an honest living by the labor of their hands."

I remain, dear sir,

Yours very truly,

CHARLES D. KELLOGG,

General Secretary.

The following table of reformatory and similar institutions is given for the purpose of presenting in a single view a few leading facts respecting their work and administration, with special reference to the industries there taught.

Table Showing Industries Taught in Various Reformatories

NAME OF INSTITUTION.	Location.	AGE. Admission.	AGE. Discharge.	NO. OF PUPILS. Males	NO. OF PUPILS. Females	How sustained.	Expenditures per annum.	Character of institution.
1. Boys' Industrial School,	Near Lancaster, Ohio,	10 to 16	21	482	370	By the State,	$60,000	Penal.
2. Cincinnati House of Refuge,	Cincinnati, Ohio,	under 16	males, 21; females, 18	187	197	Municipal taxation,	54,444	Penal.
3. Convent of the Good Shepherd,	Newport, Ky,	not under 8	18	.		Ind. & charit. dona.	26,432	
4. House of Reformation for Colored Boys,	Cheltenham, Md.,	under 16	21	270	. .	By the State and city,	.	Penal.
5. Illinois Industrial School for Girls,	South Evanston, Ill.,	under 18	18		100	By the counties,	60,000	Home.
6 Indiana Reform School for Boys,	Plainfield, Ind.,	8 to 17	21	490		By the State,	. . . .	Penal.
7. Iowa Industrial School for Girls,	Mitchellville, Iowa,	under 16	21		115	By the State,	17,000	Penal.
8. Lawrence Industrial School,	Lawrence, Mass,	8 to 15	expiration of sentence	33	. . .	By the city,	6,000	Penal for truancy.
9. Lyman School for Boys,	Westboro, Mass.,	7 to 15	21	104		By the State,	30,072	Criminal.
10. Asylum of the Good Shepherd,	Detroit, Mich,	2 to 100			120	Ind. and donation,	. . .	Home.
11. New Bedford Truant School,	New Bedford, Mass.,	10	16	12	.	By the city,	1,924	Penal for truancy.
12 State Industrial School for Girls,	Trenton, N. J.,	7 to 16	21		45	By the State,	6 500	Penal.
13. New York Catholic Protectory,	New York	7 to 16		1,556	721	City ind. & vol. aid,	340,920	Penal of minor grade.
14 New York House of Refuge,	Randall's Island, N.Y.	under 16	21	543	111	By State & industry,	120 956	Corrective.
15. New York Juvenile Asylum,	New York,	7 to 14	9 to 16	766	210	By the city,	120,000	Corrective.
16. Penitent Female Refuge,	Boston, Mass.,	12 to 30	14 to 32		22	Donation,	. . .	Penal.
17. Penna. Reform School,	Morganza, Pa.,	8	21	320	115	By the State & cos.,	.	Reformatory.
18 Plummer Farm School,	Salem, Mass.,	under 16	at 18	30	.	Income from fund,	5 938	Penal.
19. Reformatory Institution for Women,	Indianapolis, Ind.,	8 to 15	18		136	By the State,	30 000	Penal
20. State Industrial School,	Golden, Col.,	10	17 to 20	417	17	By the State & ind.,	31 460	Penal.
21. State Industrial School,	Manchester, N. H.,	8 to 17	9 to 21	98	22	By State & board,	13 000	Penal.
22. State Industrial School for Girls,	Lancaster, Mass.,	7 to 17	21		68	By the State,	18,000	Penal.
23. State Industrial School for Girls,	Adrian, Mich.,	10 to 17	21	. . .	210	By the State,	41 630	Penal.
24. State Reform School,	North Topeka, Kan,	8	21	219		By the State,	31 230	Penal.
25 State Reform School,	Portland, Me.,	8 to 16	any age,	113	33	By the State,	23 000	Corrective.
26 State Reform School,	St. Paul, Minn.,	under 16	21	217	150	By the State,	46 586	Penal.
27 Wisconsin Industrial School for Girls,	Milwaukee, Wis,	18	21	50	. .	By the counties,	22 068	Corrective and penal.
28 Wisconsin Industrial School for Boys,	Waukesha, Wis.,	10 to 18	21	340	.	By the State,	31 416	Penal.
29. State Reformatory,	Elmira, N. Y.,	16 to 30		747	. . .	Ind. & by State,	116 275	Penal.
30. House of Refuge,	Philadelphia,	7 to 16	9 to 18	584	168	By the State & city,	206,030	Corrective and penal.

Table Showing Industries Taught, etc.,—*Continued.*

Name of Institution.	Occupation of Pupils. Hours in shop.	Hours in school.	Recreation.	Industries Taught.
1. Boys' Industrial School,	4	4	3 & Sat'y p. m.,	Knitting, printing, shoe and brush making, carpentry, polytechnic work, mechanical engineering, laundering, blacksmithing, tailoring and farming.
2. Cincinnati House of Refuge,	6	3	3	Shoemaking, tailoring, knitting and carpentry.
3. Convent of the Good Shepherd,	. . .	4	2½	Fine and plain sewing, embroidery, lacemaking, knitting and general housework.
4. House of Reformation for Colored Boys,	4½	4½	5	Farming and gardening.
5. Illinois Industrial School for Girls,	6	4½	2	Housework.
6. Indiana Reform School for Boys,	5	4	3	Carpentry, blacksmithing, bricklaying, brush, shoe and chair making, tailoring and gardening.
7. Iowa Industrial School for Girls,	4 to 6	4 to 6	5	Domestic economy.
8 Lawrence Industrial School,	5	4½	3	Chair seating and farming.
9. Lyman School for Boys,	6	4	5	Farming, domestic work carpentry, caning chairs, printing and shoemaking.
10. Asylum of the Good Shepherd,	. . . . .	2	2	Tailoring, fine sewing and housework.
11. New Bedford Truant School,	. . .	5	. . . .	None
12. State Industrial School for Girls,	. . .	3	1½	Housework and shirt making.
13. New York Catholic Protectory,	4½ to 6	4 to 5	3 & 4	Printing, shoemaking, electrotyping, tailoring, chairmaking, farming and gardening, sewing, glovemaking and housework.
14. New York House of Refuge,	7 to 8	3½ to 4	3 to 4	Printing, carpentry, hosiery and gardening.
15 New York Juvenile Asylum,	3½	3 to 4½	1½ to 3½	Engineering, carpentry, shoemaking, tailoring, farming, baking, laundering and housework.
16 Penitent Female Refuge,	8	1 to 2	3	Domestic work and sewing.
17. Penna Reform School,	4¾	6½	3	Clothing, shoe and brushmaking, farming, etc.
18. Plummer Farm School,	6	4	5	Gardening and chair seating.
19 Reformatory Institution for Women,	4¼	4½	3	Housework and sewing, laundery work, chair caning and painting.
20 State Industrial School,	6½	4	2½	Broom and shoemaking, carpentry, painting, baking, laundery work, farming and cooking.
21. State Industrial School,	5	4½	3	Chair seating, hosiery and farming
22. State Industrial School for Girls,	. .	3½	2	Sewing, knitting and domestic work.
23 State Industrial School for Girls,	7	3½	1½	Domestic work and sewing.
24. State Reform School,	4½	4½	. . . .	Farming and gardening.
25 State Reform School,	6	4	4	Carpentry, farming, tailoring, cane seating, laundery and baking.
26 State Reform School,	4	4	1 to 3	Wood working, tinsmithing, carpentry, shoemaking, tailoring and gardening.
27. Wisconsin Industrial School for Girls,	5½ to 7	6	1½	Housework, sewing, knitting and dressmaking.
28. Wisconsin Industrial School for Boys,	5	4	2	Boot and shoemaking and knitting.
29. State Reformatory,	8	2	. . . .	Molding blacksmithing, plumbing, bricklaying, plastering, stone and wood work, carpentry, shoemaking, printing, telegraphing and stenography.
30. House of Refuge,	6½	3	3	Tailoring, shoemaking, brushmaking, caneseating and baking.

D.

By DR. N. C. SCHAEFFER.

NORMAL SCHOOLS.

In accordance with the duty assigned me I have written to the State Superintendents of all the States in the Union which have normal schools recognized by law, and have gathered the following information:

1. The following States offer free tuition to all students preparing to teach: Alabama, Connecticut, Illinois, Iowa, Louisiana, Maine, Massachusetts, Missouri, Nebraska, New Hampshire, New Jersey, New York, Rhode Island, Texas, West Virginia, Wisconsin.

California offers free tuition to all students of that State.

In Iowa, a fee of $1 per month is paid for contingent expenses.

Kansas offers free tuition to all students who take the regular course and defrays railroad fare in excess of $3.

Maryland offers free tuition to students if they have been regularly appointed by the school board of the city or county in which they reside.

Massachusetts offers free tuition and some State aid besides.

In Michigan each member of the State Legislature may make two appointments to the normal school. These students are required to pay no tuition fee. All others pay a small fee.

In Minnesota, tuition is free to residents of the State who pledge to teach two years.

In South Carolina, tuition in the Winthrop Training School at Columbia is free to one pupil from each county in the State.

In Texas, tuition, text books and use of libraries are free to all students. Half the board of one hundred and sixty-nine students is paid by the State.

In Vermont, there are two hundred and forty-three free scholarships for the three State normal schools.

2. The salaries of the instructors are paid out of State funds in all these States except Illinois, Kansas, South Carolina, Vermont, West Virginia, Wisconsin.

In Illinois, the salaries are paid in part from the fund derived from the sale of lands given to the State when it was admitted into the Union. The amount from this source is less than $13,000. The remainder of the money for salaries is paid from the State treasury.

In Kansas, the salaries are paid out of an income of $17,000 from invested funds and the balance from incidental fees.

In Wisconsin, there is an endowment fund of $1,200,000, and if this

source of income is insufficient, the Legislature makes an appropriation to pay the deficit. The State has 200,000 acres of unsold land.

In South Carolina, West Virginia and Louisiana the salaries are partly paid by donations from the Peabody fund.

3. The following table exhibits the amount of appropriation to each school for maintenance and other purposes:

Alabama,	Florence,	$7,500	Average to each school, $3,750.
	Huntsville,	4,000	
	Tuskegee,	3,000	
	Troy,	3,000	
	Jacksonville,	2,500	
	Livingstone,	2,500	
California,	San Jose,	40,000	
	Los Angeles.,	19,750	
Connecticut,		17,000	
Illinois,	Normal,	21,000+proceeds of fund	=27,493 56
	Carbondale,		=27,060 00
Iowa,		15,100	
Kansas,		23,000	Income of fund, $17,000; State appropriation usually from $3,500 to $6,000.
Louisiana,		8,500	
Maine,		19,000 for three schools.	
Maryland,		10,500	
Massachusetts,		14,000	Normal Art School, $16,000.
Michigan,		68,000 for 1887.	
		32,500 for 1885.	
		27,000 for 1883.	
Minnesota,	Winona,	18,000	
	Mankato,	16,000	
	St. Cloud,	16,000	
	Moorehead,	5,000	
New Jersey,		20,000	
New York,	from	18,000 to $23,500 for maintenance.	
Missouri,		12,500	
Nebraska,		20,000	
New Hampshire,		7,000+2,000 from Plymouth.	
Rhode Island,		12,000	
South Carolina,		5,100	
Texas,	Sam Houston,	25,000	
	Prairie View,	15,000	

4. Manual training has received very little attention in the normal schools of these States. The Maryland Normal School teaches wood work to the young men and cooking and sewing to the young women. The Prairie View Normal School in Texas began this year with work in wood and metals, and with sewing and cooking for girls—appropriation, $5,000. The schools at Whitewater and Milwaukee, in Wisconsin, have a shop department in which pupils are trained in the use and care of common tools, and general principles relating to the construction of simple forms in wood work, in lathe and forge work.

A large part of the students are females from sixteen to twenty-five years of age. They learn to handle hammer, saw, square, auger, bit, plane, chisel, forge, lathe, etc., etc., making various articles of furniture, apparatus involving varied forms of joints, mortises, tenons, etc., etc.

For several years the pupils (ladies) of the State Normal School at Salem, Mass., have been offered instruction in the use of carpenters' tools. From fifty to sixty volunteered to learn the use of hammers, saws, planes, augers, etc., etc. The amount of time given to this work was not large (one lesson of one hour each week), but much interest was shown in the work, and many articles, such as easels, book cases,

were made by the young ladies for their own use. Principal Hagar says that the results are satisfactory.

The Legislature of New York passed an act in 1888 requiring the State normal and training schools "to include in their courses of instruction the principles underlying the manual or industrial arts, and also practical training in the same to such an extent as the Superintendent of Public Instruction may prescribe, and to such further extent as the local boards respectively of said normal and training schools may prescribe."

Table of Average Appropriations to each School, &c.

	Tuition.	Average annual appropriation from State Treasury.	Income from invested funds.	Remarks.
Alabama,	Free,	$3,750 00		
California,	Free,	29,875 00		
Connecticut,	Free,	17,000 00		
Illinois,	Free,	27,276 78	$13,000 00	
Iowa,	Free,	15,100 00		
Kansas,	Free,	32,000 00	17,000 00	Defrays railroad fare of each student in excess of $3.00.
Louisiana,	Free,	8,500 00		
Maine,	Free,	6,333 33		
Maryland,	Free,	10,500 00		
Massachusetts,	Free,	14,000 00	. . . .	State aid besides.
Michigan,	. . . .	34,000 00		
Minnesota,	. . . .	13,750 00		
Missouri,	Free,	12,500 00		
Nebraska,	Free,	20,000 00		
New Jersey,	. . .	20,000 00		
New Hampshire,	Free,	9,000 00		
New York,	Free,	19,388 00	. . . . .	Each normal school has shops for manual training.
Pennsylvania,	. . . .	5,000 00	. . . .	The State pays fifty cents a week to certain students and $50.00 as a graduation fee.
Rhode Island,	Free,	12,000 00		
South Carolina,	Free,	5,100 00		
Texas,	Free,	20,000 00	. . . .	Free text books and free use of libraries. Half the board of 169 stu ents is paid.
Vermont,	Free,	. . . . . .	. . . . .	243 free scholarships.
West Virginia,	Free,	2,200 00		
Wisconsin,	Free,	10,000 00	1,200 00	All the normal schools except one were wholly supported by the income of the fund.

From the foregoing statements it is evident that our sister States have been far more liberal towards their State Normal Schools, and that several are in advance of our State in the matter of manual training. Principal Lytle of Millersville says they have begun wood-work in one of their recitation rooms, which has been fitted up for the purpose. This school, which is the oldest in the State, has perhaps more room in its buildings than any other school. Nevertheless the prin-

cipal says: "To be properly equipped we should have a new building, and should need an appropriation from the State to erect and furnish it. Probably the buildings for the different schools could be erected by the State on the same general plan." In the State Normal Schools of Pennsylvania manual training has been given chiefly in the form of penmanship and drawing, and upon the play ground in the shape of base ball. The results in penmanship and drawing are comparatively satisfactory; the instruction in these branches is constantly improving, and no change need here be recommended. But the time and effort spent upon base ball might be turned to better account. The manual skill developed by this game is truly marvelous. Think for a moment of the elements in the problem which the pitcher or the catcher must solve! Dr. Thomas Hill, ex-president of Harvard, says: "The epicycloidal theories of Hipparchus, the Newtonian theory of gravitation, the resolution of centripetal and centrifugal forces, the conic sections of Appolonius, and the modifications of these curves by the resistance of the air—all these are involved in the problem and must be practically solved before the school boy can give his fellow a good ball or catch one on the fly." If the same time were spent upon work in wood and metals, it would furnish less exhaustive and more valuable exercise for both body and mind, and a kind of manual skill would be developed that would be of the highest utility in subsequent life.

In the construction or repair of school apparatus many teachers are very helpless. They do not know how to fashion wood, to mold iron, to solder tin, to cast lead, to temper wire, to manipulate glass, etc., simply because they have not been taught these processes. A course in manual training would enable teachers to construct at small expense much of the apparatus which they need; and the instruction in our public schools might thus be greatly improved.*

There is nothing to hinder the introduction of work in wood and metals and of instruction in sewing and cooking, except the lack of funds with which to provide the necessary tools and appliances and to pay for the additional teaching that would be required.

*Prof. S. R. Thompson, of Westminster College, New Wilmington, Pa., (formerly State Superintendent of Nebraska), promised his trustees that if they would give him $500 to invest in tools, materials, etc., he would at the end of the year turn over to the institution a thousand dollars worth of apparatus for the teaching of physics. The value of the apparatus by catalogue prices was found to exceed $1,100.00. Prof. Thompson claims that with $25.00 worth of materials he can make apparatus for at least 300 of the experiments described in text books. Among other things he has constructed a machine for measuring the hourly growth of a plant.

Prof. J. P. Naylor of the University at Bloomington, Indiana, claims that a teacher's manual skill should enable him to make all the apparatus needed to teach Gage's Introduction to Physics experimentally, with the exception of the following pieces: 1. Balances; 2. Atwood's machine; 3. Eight in one apparatus; 4. Siren in one apparatus; 5. Air-pump; 6. Aneroid Barometer; 7. Thermometer; 8. Concave and convex mirror; 9. Glass prism; 10. Set of lenses; 11. Pocket spectroscope; 12. Ruhmkorff's coil; 13. Pascal's apparatus: 14. Pieces requiring skill in glass blowing.

Without doubt the chief hindrance to the complete success of the normal schools has been their inability to secure and keep the highest order of teaching talent. The higher salaries of the city and county superintendencies, and of professorships in our high schools and colleges, the greater emoluments of the three older professions, and the more profitable lines of modern business are constantly drawing away from our normal schools their most successful teachers. This difficulty cannot be overcome so long as the salaries must be derived from tuition fees paid by the students, most of whom have been or will be but poorly remunerated for their work as teachers in the public schools. In view of these facts it would be wise at no distant day to inaugurate in Pennsylvania the policy of her sister States which provide by appropriation for the salaries of the instructors in their normal schools, thus offering free tuition to all students who are preparing to teach.

E.

By Superintendent GEO. J. LUCKEY.

INDUSTRIAL EDUCATION IN THE PUBLIC SCHOOLS OF PENNSYLVANIA.

At the first meeting of this Commission, held in Harrisburg, December, 1887, I was requested to inquire into the extent to which manual training had been introduced into the schools of the State, and report the result of my inquiries to the Commission, and to make such suggestions as I thought prudent and wise with reference to State aid for the furtherance of this branch of school work in the public schools of the Commonwealth. By travel and correspondence I find that no steps have yet been taken by the local school authorities looking for the introduction of any branch of manual training in any of the ungraded country schools of the State; but in quite a number of the populous centers a beginning has been made, and the results have been very generally commended by the intelligent people of these localities. In Philadelphia the movement has assumed a very considerable magnitude, and the school authorities have ceased to talk of it as an experiment, and are actively engaged in making provision for its general introduction into all the grades of the city schools. Several excellent institutions of a higher grade, for the education of young men for the arts and industries have long existed in Philadelphia, and the excellent work done by them has created a public sentiment in favor of eye and hand training which does not exist in most sections of the State, and this sentiment has greatly aided the school officials in their present efforts to lay the foundation for this work in the pub-

lic schools of the city. If there were no other examples presented, the work already done in Philadelphia would sufficiently demonstrate the utility and feasibility of making manual training a part of the course of study in all graded schools. While other cities and a number of towns in the State have made satisfactory experiments in this line, none have as yet incorporated it permanently into their school system. Pittsburgh, encouraged by the generous offer of Mr. Henry Phipps, Jr., to provide a teacher, opened a school kitchen for the training of young ladies in the art of cooking; this school has already demonstrated the wisdom of its projector, and will most likely become part of the school system. A number of small towns on the Allegheny river have made experiments in the simpler kinds of wood and iron work, and in every locality visited or officially heard from, every effort made to extend the course of study in an industrial direction has met and is meeting the approval of the citizens.

While my instructions did not contemplate any investigation of this subject beyond the limits of the Commonwealth, I have, nevertheless, visited a number of cities in other States where extensive experiments have been made in this line of school work, and while in none of them is the work so extensive or general as in Philadelphia and Boston, yet in Baltimore, Washington, Toledo and Cleveland, they have each a single plant in which, however, very thorough and practical work is done for a certain advanced grade of pupils. In most cities where there is a single school, the plant has been established by private enterprise, and although under the charge of the public school authorities, it is usually for advanced pupils, and its advantages are not within reach of the great mass of pupils that attend the public schools. Often the very class of pupils that would be the most inclined to attend these schools and who need most the training here offered, do not, nor cannot, remain in school long enough to be admitted.

It will thus be seen that in order to extend the advantages of manual training to all classes of children, the plan of establishing special schools and employing special teachers must be abandoned, and our corps of regular teachers must be fitted and qualified to do as successful and thorough work in this line as they now do in the required school branches.

In presenting this idea to a number of prominent men, I have been uniformly met by the question "are all our teachers to be educated in carpentering, tailoring, cooking and machine building?" thus showing that the fundamental idea of manual training is often misunderstood by many of our most intelligent citizens. Hence it is that I place second in importance to the education of our teachers for their work, the proper education of the people in the objects to be attained by manual training. Somehow the idea has become general, that manual training means the training of children for specific trades, and that the children are to be fitted in the schools to be machinists, car-

penters, joiners, dressmakers and professional cooks, while the true idea that a hand and eye training is a necessary supplement to mental training, to round out and complete the education of all the child's powers and faculties and properly fit him for all (not any one) of life's callings is only understood by the few. Reading, writing, arithmetic, geography and grammar are as much a special training for the professions, and no more, than manual training is for the trades. While the idea of trades should be scrupulously avoided in presenting any plan for the introduction of industrial work in the common schools, I desire to call your attention specially to the great need of making provision for the special education of the inmates of our reformatories, in some of the common industrial callings, so that when they are released from these institutions they may be able to find readily some useful and honorable employment and not be driven by necessity to join the already large and growing army of professional tramps that throng our highways. And, if not foreign to the objects for which our Commission was organized, I would like to suggest to you the propriety of recommending to the Legislature the necessity of taking some steps toward securing compulsory primary education.

We must not forget that we are a republic, and that every citizen is a sovereign, and that the perpetuity of our free institutions depends upon the intelligence, virtue and culture of the people. The rapid growth in population, and the great influx of an uneducated foreign element that appears to have but little interest in the proper rearing of their children, have produced a long list of uneducated voters in our Commonwealth, and the law of self-preservation demands that some compulsory measure be adopted that will secure to every child in the State the advantages of a primary education, thus making him an intelligent, helpful and useful member of society.

Respectfully,

GEO. J. LUCKEY.

APPENDIX I.

TECHNICAL AND INDUSTRIAL EDUCATION IN THE UNITED STATES.

Technical and industrial education in the United States has assumed several different forms. It has been established either by private initiative or by State action as a higher scientific and technical education, sometimes independently, sometimes as a branch of larger institutions; and it has in a large number of instances been established as manual training or as trade training, in connection with special grades of the public school system, or as single establishments supported by the munificence of individuals. Previous to 1862 there had been established in the United States only four important scientific institutions, viz: the Rennesselaer Polytechnic School of Troy, New York; the Lawrence Scientific School at Cambridge, Mass., in connection with Harvard University; the Sheffield Scientific School at New Haven, Conn., in connection with Yale College; the Chandler Scientific School, in connection with Dartmouth College, at Hanover, N. H., and the Scientific School, in connection with Union College, at Schenectady, N. Y. Of these, only the Troy Polytechnic was a separate institution, and all of them were chiefly occupied with mathematical instruction, pure and applied. Besides these should be mentioned, perhaps, the United States Military Academy at West Point, and the United States Naval Academy at Annapolis, both established and maintained by the United States Government, and having the special aims indicated by their names.

Under the act of Congress of July 2d, 1862, which is mentioned in the body of the report, one or more institutions have been established, in each State of the Union, the "leading object" of which, as stated in the words of the law, is "to teach such branches of learning as are related to agriculture and the mechanic arts." The development of these institutions has varied largely according to local requirments. Some of them have devoted themselves almost or quite exclusively to instruction in the sciences directly related to agriculture; others have covered a wider field. Several of them have given special attention to instruction in the mechanic arts, extending it to include all the leading branches of mechanical and physical science, combined with an extensive course of training in shop work.

The most important of those belonging to the latter class are mentioned in the accompanying list. Besides the institutions founded upon the law of 1862, several have been established since that date

which have attained high rank in these particular departments, such as Stevens Institute, at Hoboken, N. J.; Tulane University, at New Orleans, La.; Lehigh University, at Bethlehem, Pa.; the Rose Polytechnic Institute, at Terre Haute, Ind.; the Case School of Applied Science, Cleveland, Ohio, and several others of less importance.

In order to ascertain as fully as possible the extent to which manual training and industrial education in general is in progress throughout the United States, the following letter of inquiry was addressed to each State and Territorial Superintendent of schools:

STATE COLLEGE, CENTRE CO., PA., *July 23d, 1888.*

DEAR SIR : Will you be kind enough to send me for the use of this Commission any copies of your annual report, which contain statements or discussions of the subject of industrial education, and especially any other documents that your office may have published, treating particularly on this subject. I desire also to ascertain how far the subject has been introduced into the schools of your State, either public or private; and if you would have the accompanying blank filled out, so that I may ascertain the results of the work in such places, it would be a very important service to our State and to the Commission.

Very respectfully yours,
GEO. W. ATHERTON.

Replies to this letter were promptly sent by the State Superintendents of Alabama, Colorado, Connecticut, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Maryland, Massachusetts, Minnesota, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oregon, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, West Virginia and Wisconsin. They not only named the places where industrial education is in progress, but their replies were accompanied in many cases with documents, and in some with helpful suggestions.

On receipt of these replies, the following letter was addressed to each institution or officer mentioned in them :

STATE COLLEGE, PA., *September 14, 1888.*

DEAR SIR: It would be a very great service to the Commission and to myself personally, if you could send me copies of your reports or other documents giving full accounts, either of your work in manual training or of any discussion, municipal ordinances, or other legislation relating to it. I should be especially glad of anything you may have indicating the results of the work thus far, and the attitude of the public mind towards it. No details can be too minute to be of service. I shall be glad to reciprocate your courtesy by any means in my power.

Yours very respectfully,
GEORGE W. ATHERTON.

The responses to this letter have been most ample and generous, including not merely printed documents, but in several instances, full and detailed statements specially prepared for the use of the Commission. It will be found, accordingly, that the facts presented in this report embody the results of the most varied and most recent experience, and may be accepted as furnishing a trustworthy guide for similar undertakings in this Commonwealth, which, in many respects, it will be seen is not behind her sister States.

The following list thus obtained, supplemented in part from other

sources, will give some idea of the extent to which this work has been entered upon. The list includes several which should be classed under the head of technical or scientific institutions, devoting themselves principally to the higher branches of such instruction, and having little or no relation to the public school systems of their respective States; but while such institutions are not directly connected with the inquiries in which this Commission was primarily interested, it seemed desirable to give them a place in the enumeration, in order to indicate the facilities already provided for higher as well as for lower technical training. Much care has been used to make the list as nearly complete as possible, and it is believed to contain every place in which manual training has been undertaken to any important extent; yet the movement in this direction is so general that it would not be surprising to find that schools had been established even while this report is going through the press. It should be added, to avoid misapprehension, that the list does not include the institutions known as "industrial schools," which are to be found in very many places throughout the country. Such schools are generally, if not always, either charitable or corrective, and designed for poor, homeless or otherwise unfortunate children. Manual occupations are there followed for the purpose of giving employment and forming habits of industry, rather than with an educational aim, and therefore have no place in the present work.

Places in which Technical or Industrial Education is Carried on.

In the State of Alabama:

Auburn, State Agricultural and Mechanical College; *Montgomery*, ———; *Tuskegee*, Normal School; *Huntsville*, ———.

In the State of Colorado:

Denver, Denver University (Haish Manual Training Department); *Fort Collins*, State Agricultural College.

In the District of Columbia:

Washington, Public Schools.

In the State of Connecticut:

Mansfield, Storrs Agricultural College; *New Britain*, Normal School; *New Haven*, Public Schools.

In the State of Florida:

Jacksonville, Colored Graded School.
Lake City, State Agricultural College.

In the State of Georgia:

Atlanta, Atlanta University; School of Technology.

In the State of Illinois:

Beardstown, Public Schools.
Chicago, Chicago Manual Training School.
Moline, Public Schools.
Peru, Public Schools.
Urbana, Illinois State University.

In the State of Indiana:

Indianapolis, Public Schools.
Lafayette, Purdue University.
Terre Haute, Rose Polytechnic Institute.

In the State of Iowa:

Ames, State Agricultural College.

In the State of Maine:
Orona, The State College of Agriculture and the Mechanic Arts.

In the State of Maryland:
Baltimore, Public Schools.
Kent county, Public Schools.
McDonogh, McDonogh Institute.
Talbot county, Public Schools.

In the State of Massachusetts:
Boston, Public Schools; Institute of Technology.
Cambridge, Public Schools (Rindge Manual Training School).
New Bedford, Public Schools.
Salem, Girls' Normal School.
Springfield, Public Schools.
Worcester, Worcester Polytechnic Institute.

In the State of Minnesota:
Minneapolis, Public Schools; University of Minnesota.
St. Paul, Public Schools.

In the State of Missouri:
St. Louis, Polytechnic School of Washington University.

In the State of Nebraska:
Omaha, Public Schools.

In the State of Nevada:
Carson City, Carson High Schools; State Orhpans' Home.

In the State of New Hampshire:
Concord, Public Schools.
Dover, Public Schools.
Manchester, Public Schools.
Nashua, Public Schools.

In the State of New Jersey.
Elizabeth, Public Schools.
Hoboken, Public Schools; Stevens Institute of Technology.
Montclair, Public Schools.
Morristown, Public Schools.
Newark, Public Schools.
Orange, Public Schools.
Vineland, Public Schools.

In the State of New York.
Albany, High School.
Brooklyn, Pratt Institute,
Ithaca, Cornell University.
Jamestown, Public Schools.
New York City, Public Schools (12); College of the City of New York; Hebrew Technical Institute; Workingmen's School; Industrial Educational Association.
Troy, Rennesselaer Polytechnic Institute.

In the State of Ohio:
Cincinnati, Technical School.
Cleveland, Case School of Applied Science; Manual Training School.
Toledo, Manual Training School.

In the State of Pennsylvania:
Carlisle, Indian School.
Haverford, Haverford College.
Philadelphia, Manual Training School; Girard College; Pennsylvania Museum and School of Industrial Art; Spring Garden Institute.
South Bethlehem, Schools of Civil and Mechanical Engineering, Mining and Metallurgy (Lehigh University).
State College, The Pennsylvania State College (department of Mechanic Arts and Mechanical Engineering).

In the State of Pennsylvania—*Continued.*

Swarthmore, Swathmore College.

Tidioute, Manual Training School.

In the State of Rhode Island:

Newport, Girls' Industrial School; Boys' Industrial School.

Providence, Friends' School; Incidentally in some of the Public Schools.

In the State of South Carolina:

Charleston, Porter Academy.

Chester, Brainerd Institute (colored).

Columbia, South Carolina University; Benedict Institute (colored).

Orangeburg, Claflin University (colored).

In the State of Virginia:

Blacksburg, Virginia Agricultural and Mechanical College.

Crozet, Miller Manual Labor School.

Hampton, Hampton Normal and Agricultural Institute.

Richmond, Mechanics' Institute.

In the State of Wisconsin:

Tomah, Public Schools; *Sparta*, Public Schools; *West Eau Claire*, Public Schools; *Whitewater*, State Normal School; *Milwaukee*, State Normal School; *Staughton*, Public Schools; *Madison*, University of Wisconsin.

The superintendents of schools in the following States and Territories failed to reply to the repeated inquires of the commission:

Arizona, Arkansas, California, Dakota, Delaware, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Michigan, New Mexico, Texas, Utah, Washington and Wyoming.

The following accounts of the organization and work of different institutions is arranged in the order of States alphabetically. It would be more useful for some purposes to classify the institutions in groups, according to their general character and aim; but, aside from the inherent difficulties of such a classification, the present arrangement seems more desirable as showing the extent of the distribution of industrial education throughout the country. Not all institutions mentioned in the preceding list are described in the following pages. The design has been to include all the most important instances of industrial education not above the high school grade, in connection with, or in close relation to the public schools, with a sufficiently full account of a few typical institutions of higher grade.

The information given is compiled mostly from documents issued by the institutions themselves, but quotation marks are introduced only in cases where passages of considerable length are quoted without change of phraseology or arrangement:

1. ALABAMA.

1. The Alabama Polytechnic.

"The Alabama State Agricultural and Mechanical College," or "The Alabama Polytechnic Institute," at Auburn, makes manual training obligatory upon students of the three lower classes of the college. The full work of each class is six hours per week, in three exercises of two hours each.

The nature of the work in each department is as follows:

FIRST YEAR.

I. A course of carpentry (hand work, covering the first term and part of the second, or about five months).

The lessons include instruction on the nature and use of tools, instruction and practice in shop drawing, elementary work with plane, saw, chisel, etc., different kinds of joints—timber splices, cross joints, mortise and tenon, mitre and frame work, dovetail work, comprising different kinds of joints used in cabinetmaking, light cabinet work, examples in building, framing, roof trusses, etc.

II. A course in turning, extending through the three months of the third term. The lessons comprise, first, nature and use of lathe and tools, plain straight turning, caliper work to different diameters and lengths, simple and compound curves, screw plate and chuck work, hollow and spherical turning.

SECOND YEAR.

I. A course in patternmaking, covering the first half of the first term. The work includes a variety of examples of whole and split patterns, core work, etc., giving the students familiarity with the use of patterns for general molding.

II. A course in molding and casting in iron and brass, occupying ten weeks. The work consists for the most part of small articles, such as light machine parts; but a sufficient variety of forms are introduced for the student to acquire a good general practical knowledge of the usual methods and appliances used in light foundry work. Most of the work is in green sand in two-part flasks. Core work is also given, and some three-part flask and some dry sand work is introduced.

The same patterns which have been previously made by students are used, besides special patterns for occasional larger or more complicated work. Instruction and practice is given in working the cupola, each student in turn taking charge of a melting.

III. A course in forge work in iron and steel occupying the remainder of the year. The lessons are arranged so that the students, in mak-

ing the series of objects, become familiar with the nature of the metals and the successive steps in working them by hand into simple and complex forms, as drawing, upsetting, bending, cutting, punching, welding by various methods, tool forging, hardening, etc.

In connection with this second year work, a series of lectures is given on the matallurgy and working of the metals used in the industrial arts, cast and wrought iron, steel, brass, etc.

THIRD YEAR.

I. A course in chipping and filing covering the first term. The lessons comprise work on cast and wrought iron, chipping to line on flat and curved surfaces, key-seating, etc., filing and finishing to line (straight and curved), surface filing and finishing, fitting, slotting, dove-tail work, sliding and tight fits, sawing, pin, screw and key filing, surface finishing with scraper, etc.

II. Machine work, occupying the remainder of the year. The work includes cast and wrought iron, steel and brass, turning to various diameters and lengths, taper turning, facing with chuck and face plate, drilling both in lathe and drill press, reaming, boring, screw cutting in lathe and with taps and dies, planing, slotting, etc., with planer and shaper, milling various forms with the milling machine, fitting, grinding, polishing, etc.

Lectures are also given during the year on various subjects connected with machine work in metals, such as forms, construction and use of the various machines, cutting tools, gearing, gauges, screw threads, etc. During the last term some piece of construction work is given the classes.

Instruction is generally given, first, by blackboard drawings or sketches which the student copies, with dimensions in note book, with which each one provides himself; thus each one works from his own notes. This is supplemented, whenever necessary, by the actual construction of the lessons by the instructor before the class; second, by inspection and direction at the bench by the instructor.

Students desiring to pursue the study of applied mechanics beyond the above course will take a special course of steam and mill engineering, supplemented by experiment and practice with the apparatus, including steam generation and the forms, construction and use of steam boilers and accompanying apparatus, steam as a motive power, and forms, construction and use of the steam engine, with the study and use of the indicator, transmission of power, shafting, belting, gearing, etc.; also elementary theoretical mechanism.

DRAWING.

Drawing is a universal language of great value as a means of education, constituting the basis of all mechanical work. No student can successfully pass through the school of mechanic arts without a knowledge of mechanical drawing; hence, it is made prominent, and

the pupils are first taught how to read and make a working drawing in plan, elevation and section.

Each exercise is placed on the blackboard as a working drawing. This the student copies in his note book, and is required to reproduce it to scale in wood or metal.

This passage from the abstract to the concrete is a mental exercise of the highest educational value. In the higher classes, he will be required to make working drawings of machines from direct measurement.

The educational, economic and social value of the work is thus set forth in a special report of the institution for 1888: "Among the many educational advantages of manual training in the mechanic arts, when associated with those studies that constitute a general and liberal education, may be mentioned the following:

(1). It satisfies and cultivates the boy's instinct for activity, and directs it towards the useful and beautiful.

(2). It excites pleasure in work and in the acquisition of skill, produces self-confidence and self-reliance.

(3). It cultivates and excites concentration, attention and perseverance. All these are required of the student to successfully reproduce his drawing in the concrete with the correct measurements.

(4). It awakens and trains the artistic powers and talents, and does this at an early age, preventing arrest by disuse, and giving opportunity for full development.

(5). It awakens and cultivates the senses and constructive faculties, and secures knowledge and power, acquired in no other way.

(6). The knowledge obtained in this school by working and doing the things required is impressive and lasting. That which is apprehended through the hand, eye and brain becomes a fixed part of the mental furniture.

(7). It teaches the student to observe, investigate, test and invent.

(8). It gives healthy exercise to different parts of the body, and thus in a great degree is a substitute for gymnastic exercises.

(9). The active occupations of the mechanic arts laboratory prevent idleness and inspire diligence, and thus give a healthy tone to the mind and character.

(10). It gives the young graduate, by the acquisition of industrial skill, the ability to do something, with consequent self-reliance and increased power.

(11). It elevates and gives dignity to manual labor. Brain power and manual skill ennoble every form of occupation.

(12). It enlarges the choice of vocations and will tend to increase the number of manufacturing enterprises, and thereby add wealth to the State in diversifying industries.

(13). The association of mental and manual training, when generally adopted in our systems of education, will have an important bearing on the solution of the problem of the relation of capital to labor."

Dr. Broun, President of the Institution, writes:

"Manual Training was introduced in the college in 1885. The engine, lathes and appliances for wood work were purchased and the lower classes were taught carpentry, turning, etc. In 1886 there were built two rooms 32x36 for forge and foundry; these were supplied with proper equipment. Our work in two years had made a favorable impression and we received a small special appropriation from the Legislature. With this there was purchased an excellent equipment for the machinery department We are now well equipped in the four departments of wood, forging, foundry and machinery.

With us each student in college, except those in the junior and senior classes, is required to take six hours a week in mechanic arts. The course is optional with the junior and senior classes.

We have had three years' experience in manual training, and are satisfied that its introduction has been of much benefit to the students and has made a most favorable impression on our patrons and the State generally. The college is now regarded as an essential factor in the educational development of the State, and will receive from it, I am very confident, all necessary support.

The work greatly interests the students. Some acquire considerable skill and do excellent work, in the short time allowed to it. Three exercises a week, two hours each, is as much as can be given here, as we have also three exercises in military drill. I regard the work in mechanic arts as a valuable educational auxiliary, that tends to aid intellectual development, form habits of industry and influence character for good. It is an educational feature of great importance, one that will in time exert a lasting influence of benefit to the State.

2. Tuskegee Normal School.

The Tuskegee Normal School was established by act of the Legislature of Alabama, passed in 1880, and was opened in a church, July 4, 1881, with thirty students and one teacher.

In the same year that the school was opened, the present location (consisting then of one hundred acres of land and three small buildings) was paid for by friends of the school outside of the State appropriation.

The corner stone of 'Porter Hall' was laid at the close of the first session, and the building was completed at the close of the second session at a cost of $6,000.

Work was begun on 'Alabama Hall' in the summer of 1884. This building, which has been completed and is now being occupied, is a brick structure 43x76, four stories high, and contains, beside dormitories for one hundred young women, dining room and kitchen for all the students and reading room and parlor for the girls. The two main halls, with the brick cottage now being erected for young men, will furnish ample accommodations for all.

The school is now in the sixth year of its existence, has eighteen officers and teachers, and an enrolment of 294 students representing nearly every county in Alabama and five States.

On the establishment of the school, the State of Alabama appropriated $2,000 annually, for its support. This amount was increased to $3,000 in 1882. The State fund is used entirely to pay tuition, but is not more than two-fifths enough to cover that item.

For money for buildings, land, apparatus and to help pay teachers' salaries, the school looks to its friends North and South.

The property is deeded to a board of trustees, six of whom reside in the North and five in the South.

Work is required of all the students for purposes of discipline and instruction, and of teaching the dignity of labor. A few students with no money work all day and attend school at night for a year. In this way they earn money with which to pay their expenses in the day school the succeeding year.

The various lines of work carried on, with the results attained, are indicated by the following extracts from the "Sixth Annual Report" of the school.

FARM.

More has been done on the farm this year (1887) than in any previous one. Good crops of corn, potatoes, peas, melons and other vegetables have been produced. These have been used, for the most part, in the school boarding department, but a quantity has been sold to outside purchasers. An addition by purchase of sixty acres of land, makes the school farm about 600 acres. Of this, 475 acres are in woods; the remainder is available for tillage each year.

The brick-yard is operated in connection with the farm. There have been made this year, 150,000 bricks for the boys' cottage and outside sale. There is a good demand for brick in the town of Tuskegee and the country around, and as there is no other yard near, the school enjoys almost a monopoly of the brick trade of the community.

SAW MILL.

This is proving one of the most paying of our industries. More than 150,000 feet of lumber have been sawed, principally, from timber from our own woods.

CARPENTER SHOP.

The work of this department has been greatly extended this year (1887). All of the wood work of buildings put up by the school, is now done by student mechanics trained in the Slater carpenter shop. Besides this, much of the furniture used by the school, as beds, tables wardrobes, benches, etc., is manufactured in this department.

None of our industries have developed more rapidly than this one and none produced better results.

PRINTING OFFICE.

The work of the school printing office will compare favorably with that of any job office in the State having no more facilities than it has.

Besides doing all of the school printing, including catalogues, reports, circulars, a monthly paper and a large amount of miscellaneous work, the office prints the minutes of conventions, bill heads, letter heads, dodgers, etc., etc., for outside parties.

The demand for negro printers in the South is much greater than the supply.

Two of the members of this year's graduating class have a practical knowledge of the printer's trade which they acquired in the school office.

INDUSTRIAL ROOM.

The work of this department has been especially creditable this year. It has employed a large number of young women daily in cutting and making garments, crocheting, embroidering and doing general repairing.

IN GENERAL.

The industrial operations of the school grow more satisfactory each year. The actual work done is of greater value to the school, and the instruction the student receives is of a more helpful character to him. In all of the work, instruction to the student is made paramount.

"Three things are accomplished through the work system, viz:

"1st. The students are enabled to pay a part of their expenses of böard, books, etc., in labor.

"2d. They learn *how* to work.

"3d. They are taught the dignity of labor."

Mr. B. T. Washington, principal of the school, writes:

"Since the establishment of this Institution, the area for industrial education has been considerably enlarged here, and as far as my experience leads me I can say that its successful operations, being closely associated with the mental training, have been entirely satisfactory. By training the hand to some industrial calling the mind of the student acquires more firmness and stability of purpose in life, and is better fitted to take in the four years' normal educational course. By learning how to work, while they are at the same time broadening their minds, the students are taught the dignity of labor, and so they become thereby useful citizens and helpful to others. In the industrial branches there have been sent forth a competent plasterer, a carpenter, a printer and young men with more practical and enlightened ideas of farming. *All the buildings on the school grounds have been erected by students' labor. The bricks were made by them, the lumber was sawed and worked up by them, and there has recently gone up a new building called 'Armstrong Hall,' wholly the work of students.*" [The italics are ours.]

II. DISTRICT OF COLUMBIA.

Public Schools of the District.

During the first eight years, systematic and progressive instruction is given, beginning with the various kindergarten exercises and continuing to more advanced work—molding and drawing—both free-hand mechanical.

In the seventh and eighth grades of the schools, work is carried on in the shops. This includes:

First Year.

(Two Hours a Week Throughout the Year.)
Seventh and Eighth Grades.

BENCH WORK.

The correct method of using planes, handsaws, chisels, gouges, brace and bits, hammer, gauge, and other tools, and the working of different kinds of wood.

The laying out of work with knife and pencil, using try-square, bevel and dividers, and working from drawings executed by the pupil himself. The making of plain and of more complex mortise-and-tenon joints, dovetailing and plain cabinet-making; articles of practical utility for the schools and shops; the putting together of work with brads, nails, screws and glue; the care and sharpening of edged tools; the use of circular saws.

Lectures on wood and other material used in the shops, showing where and in what condition each is found, and by what processes it is prepared for use or for market. Also, lectures on the manufacture of tools.

Second Year.

(Two Hours a Week Throughout the Year.)
Eighth Grade and High School.

LATHE WORK.

The use of all the hand wood-turning tools, embracing plain and fancy turning in hard and soft wood, inside and outside; the use of chucks and face plates; pattern turning.

MOLDING.

Bench molding in sand and casting soft metal, embracing the use of stickers, trowels, riddle, etc., using patterns made by the pupil himself.

FORGING.

The forging of small articles of soft iron and steel, and steel tools, with instruction in the simpler methods of manufacture of iron and steel.

Practice in welding iron.

Practice in hardening and tempering steel.

Lectures on metallurgy.

III. CONNECTICUT.

New Haven Public Schools.

The following statements, quoted from the annual reports of the Board of Education for 1887 and 1888, indicate the policy of the New Haven public schools with reference to manual training:

The decision was made one year ago, in September, 1886, to establish manual training in a central shop and to employ a permanent instructor. The room provided is eighty five feet long by twenty-five feet wide, is lighted on three sides, is easy of access, and fitted with twenty-four benches, complete sets of carpenters' tools and other conveniences.

Under the direction of a "practical mechanic and designer, with some experience in teaching, instruction was commenced November 1, 1886, and since that time ten classes of twenty-four boys each, making one class from each grammar school, has received two hours instruction each week.

The basis upon which the boys were selected is best understood from the instructions sent to the principals at that time.

"By vote of the Committee on Schools you are hereby instructed to select twenty-four boys from rooms 11 and 12 for instruction in manual arts. The selection is to be made at your discretion, with the exception that none are to be taken who have been poor in deportment or who have been negligent in their school duties. It is recommended that preference be given to those who have not had previous training of this kind and who, being desirous of it, are likely to gain a benefit from it. Those chosen as members of the several classes are not to be dropped during the year unless they fail to sustain an excellence in scholarship equal to their record prior to this time. If they clearly fail to do this they are to be dropped and others are to be substituted."

A systematic course of lessons has been given. involving use of the ordinary tools, and practice in the various steps of carpentry. Little attempt has been made to construct articles of utility.

An optional class in wood-carving attended on Saturday mornings and excellent specimens of handiwork were the result.

In both carpentry and wood-carving, working drawings were made and used as a guide. It cannot be said that all the work was performed with the care that could be desired. Some boys were heedless and seemed to lack the power of close attention and nice execution. The entire inability of some to use their hands at first and the decided gain in manual power exhibited after a few months of practice, fur-

nish strong arguments in favor of such training. Says Superintendent E. P. Seaver of Boston, concerning the value of manual training:

"This workshop or laborarory method of instruction brings the learner face to face with the facts of nature. His mind increases in knowledge by direct personal experience with forms of matter and manifestations of force. No mere words intervene. Abstract definitions, statements and rule are put aside. They are not recognized as knowledge, but only as the frames or cases into which knowledge can be put when it is got. I firmly believe that the introduction of the manual training element into our school work will promote still further their salutary reform; that it will tend to abolish the mere formal teaching, of which there is yet too much, and replace it with real teaching, a teaching that seeks to develop mental power rather than to load memory with words, to make the pupil a possessor of the solid merchandise of knowledge rather than of its empty packing cases."

These words are a fair statement of the relation of our manual training school to all other departments of teaching. Although in a crude stage of development, it is likely to grow in favor and excellence until its rightful place in the school system is determined. In the meantime it stands as a protest against the teaching of mere words, and makes its eloquent appeal for recognition on the ground that it supplies an element in education that has been almost entirely lacking.

The following is a statement of expenditures on account of manual training, 1886–87:

WOOD-WORK.		
Fitting up work-shop (repairing benches, buildings, racks, etc.),	$347 32	
Tools, and sharpening and repairing, etc.,	222 40	
Lumber, nails and other material,	98 45	
Rent,	250 00	
Insurance,	21 90	
Instruction,	640 00	
Janitor,	59 00	
		$1,639 07
SEWING.		
Baskets,	$6 35	
Needles, thread and other material,	8 64	
Travel,	51 00	
		65 99
Total,		$1,705 06
Estimated value of tools owned by the district,		$450 00
Estimated value of benches, racks, etc., owned by the district,		300 00
Estimated value of lumber and other material on hand,		10 00
Total,		$760 00

Scheme of Lessons Given at the Manual Training School.

From November, 1886, to June, 1887.

Each tool when it is first used, is described, the different parts named, and the way to hold and use it explained. After the boy has learned how to use a tool he is shown how to sharpen it on the oil stone, and is required to keep it in good order.

LESSON I.

Hammer.

1. Exercises in striking a block of wood with hammer, to show wrist, elbow and shoulder movements, and to learn to strike "square."

2. Exercises in driving nails of different sizes, perpendicularly, and in drawing them.

3. Exercises in nailing two boards, seven-eighths of an inch thick, together, with nails of different sizes, driven obliquely, and in drawing them.

Chisel and Try Square.

4. Take board six inches square, mark out the corners square, with try square and lead pencil; cut them out perpendicularly, with one inch firmer chisel.

5. Take board six inches square, round the corners with one inch firmer chisel, cutting perpendicularly; prove with try square.

LESSON II.

Chisel to Line.

1. Take piece twelve inches long, one and one-half inch wide, seven-eighths of an inch thick, and mark with rule and compass a pointed arch, at one end, and a round arch at the other end; shape out with one inch firmer chisel, cutting with the grain from sides to center of arch.

Halving.

2. Take two pieces six inches long, two and one-half inches wide, seven-eighths of an inch thick, and halve them together, using rule, try square, single gauge, scratch awl, back saw, one inch and a quarter firmer chisel, and cutting board. *Always use cutting board, to save cutting the bench.*

Half Dovetail.

3. Make a half dovetail, with one piece five inches long, one inch and a quarter wide, seven-eighths of an inch thick, and one-four inches long, one inch and a quarter wide, seven-eighths of an inch thick, using same tools as in two, except one-half inch chisel instead of one inch and a quarter.

LESSON III.

End Mortise and Tenon.

1. Take piece five inches long, one inch and a quarter square, and

for mortise in one end; take piece same size and form tenon at one end; using rule, try square, scratch awl, mortise gauge, back saw, three-eights of an inch chisel and bench vice.

Boring.

2. Take piece three inches long, one inch and a quarter square, center the sides and ends with single gauge, put in the vice, and bore half way through with one-quarter inch bit; reverse, and bore from the other end.

3. Repeat the above, using three eighths inch, one-half inch, five-eighths inch, three fourths inch and seven-eighths inch bits.

LESSON IV.

Sawing Square.

1. Take piece twelve inches long, one inch and a quarter wide, seven-eighths of an inch thick, mark two sides one inch from end, with try square and scratch awl, and saw off evenly.

2. Repeat above, sawing off piece seven eights of an inch, three-fourths of an inch, one-half of an inch, three eights of an inch, one-quarter of an inch and one-eighth of an inch.

Through Dovetail.

3. Take one piece four inches long, one and one-eighth inch square, and one piece three inches long, one and one-eighth inch square, and make through dovetail, using one-half inch chisel for cutting.

LESSON V.

Jack Plane.

1. Take piece eighteen inches long, twelve inches wide, one inch and a half thick, place on bench, flat side down, end firmly against bench hub, and plane off a few shavings with jack plane, as set.

2. Take the plane apart, naming its parts; put it together and practice setting it, comparing the shavings, until it is set correctly.

3. Take piece six inches square, seven-eighths of an inch thick, mark off the corners, forming an octagon; using rule, compass and scratch awl. Saw off corners, leaving line, and smooth edges with block plane.

Cross Cut Saw.

4. Take board eight feet long, six inches wide, seven-eighths of an inch thick, lay off a line, with try square and lead pencil, six inches from the end, and saw off, leaving line.

5. Repeat above, sawing on the line.

LESSON VI.

Grooving.

1. Take piece three inches long, three inches wide, seven-eights of an inch thick, and make a groove, one half-inch wide, one-half inch

deep, through the center, across the grain, using rule, mortise gauge, try square, scratch awl, back saw, bench hook, three eighths of an inch firmer chisel, bench vise and cutting board.

2. Take piece four inches long, three inches wide, seven-eights of an inch thick, cut a tenon on one end to fit grove; using same tools as in 1.

3. Round the ends of both pieces with firmer chisel, using try square to prove correctness of work.

4. Put together and test with try square.

Ripping Saw.

5. Take board eight feet long, twelve inches wide, seven-eighths of an inch thick, mark off with single gauge a strip two inches wide; put it on the horse and saw to line, then put the board in the bench vise, one end resting on the bench pin; plane with jack plane, and true up with jointer, using try square to prove it.

6. Repeat above, sawing on the line.

LESSON VII.

Framing.

1. Saw from stock a strip two feet long, one inch wide, seven-eighths of an inch thick, using single gauge and rip saw.

2. Square up with fore plane, trying plane and try square.

3. Saw off with back saw, piece twelve inches long, for stile, and one five inches long for rail.

4. Form mortise in stile, and tenon on rail, using bench vise, back saw, bench hook, one-inch firmer chisel, three-eighths of an inch mortise chisel and mallet.

LESSON VIII.

Framing (Completed).

1. Drive together the pieces prepared in the last lesson and smooth face with block plane.

Halving.

2. Saw from stock, piece forty inches long, one inch wide, seven-eighths of an inch thick, using rip saw.

3. Square it up with jack plane, trying plane and try square, gauging to thickness and width.

4. Cut off two pieces twelve inches long, and two eight inches long, and halve corners together, making a frame with ends projecting one inch.

LESSON IX.

Halving (Completed).

1. Round the ends of the pieces prepared in the previous lesson, using compass, firmer chisel, and wood file.

2. Put together and smooth up with block plane.

Sawing and Planing.

3. Saw from stock, piece twelve inches long, two inches square.
4. Square it and plane all sides.
5. Cut from stock piece four inches long, four inches wide, seven-eighths of an inch thick.
6. Square it and plane all sides.

LESSON X.

Gauging.

1. Center, with marking gauge, on all sides, from end to end, the twelve-inch piece prepared in last lesson.
2. Square off a line all around, three-quarters of an inch from end, then on that line, point off five-eighths of an inch on each side of center, on all four sides; from the points thus obtained, draw lines obliquely to the corners at the other end; then draw lines, from the said points, on the line squared off, to the center of the top.

Beveling.

3. Bevel with draw knife, and plane true, using bevel to prove the work.

Chamfering.

4. Chamfer the top to a point, as marked out.

LESSON XI.

Doweling.

1. Draw a line through the center of the base of the column, made in the last lesson, point off three-eighths of an inch on each side of center. Make centers with scratch awl, to bore from, and bore holes perpendicularly one inch deep, with one-quarter of an inch twist bit.
2. Glue in one-quarter inch dowels; ends to project five-eighths of an inch.
3. Center the piece four inches square, prepared in lesson IX—4. Measure three-eighths of an inch on each side, bore perpendicularly, holes five-eighths of an inch deep.
4. Set gauge three-eighth of an inch and gauge round the top and sides, chamfer off, using one-inch firmer chisel, true up with block plane and try square.
5. Glue together, making column and plinth.

LESSON XII.

Draw Knife. Planing to Line.

1. Saw from stock, strip twelve inches long, two inches square.
2. Square up sides and ends.
3. Gauge off three eighths of an inch from all the corners, put in bench vice, take off corners with draw knife and plane to line.

LESSON XIII.

Mortising.

1. Saw from stock, two pieces twelve inches long, one and one-half inch wide, seven-eighth of an inch thick for stiles, and two pieces eight inches long, one and one-half inch wide, seven-eighths of an inch thick for rails.
2. Square them up.
3. Form mortise in stiles, and saw tenon in rails.
4. Mortise to be two-thirds the thickness of the stile, rails to enter stiles three-quarters of an inch from the end, and tenons to project five-eighths of an inch.

LESSON XIV.

Mortising (completed).

1. Finish up and fit mortise and tenon, commenced in last lesson, with chisel.
2. Round the ends of tenons.
3. Drive together, and plane off back and front.

LESSON XV.

Glue Joint.

1. Saw from stock, two pieces three feet long, three inches wide, seven-eighths of an inch thick.
2. Plane the edges square, with jack plane, trying plane, and try square.
3. Joint together.

LESSON XVI.

Beveling.

1. Saw from stock, two pieces three feet long, three inches wide, seven-eighths of an inch thick.
2. Square them up.
3. Mark on edge with bevel (set to templet 45°), and plane to bevel with jack plane, fore plane, and trying plane.

LESSON XVII.

Blind or Mitre Mortise.

1. Saw from stock, two pieces six inches long, two inches wide, seven-eighths of an inch thick.
2. Square them up.
3. Make mitre mortise and tenon, using try square, scratch awl, mortise gauge, back saw, three eighths of an inch mortise chisel, and bevel.
4. Put the mortised piece in mitre board and plane true.

LESSON XVIII.

Blind or Mitre Mortise (completed).

1. Drive together the pieces made in last lesson.

2. Level off faces and ends with block plane.
3. Round the ends to finish.

LESSON XIX.

Mitreing.

1. Saw from stock, strip eighteen inches long, three inches wide, seven-eighths of an inch thick.
2. Smooth it up and square it.
3. Cut into four pieces, four inches long.
4. Mark corners of each piece on flat side with scratch awl and bevel (set to templet 45°).
5. Put in mitre box and saw to line.
6. Put in mitre board and true up.
7. Fit together and test with try square.

LESSON XX.

Mitreing (completed).

1. Glue together the pieces made in the last lesson, and key it, making a frame.

Dovetail.

2. Saw from stock, two pieces four inches long, three inches wide, seven-eighths of an inch thick.
3. Square them up.
4. Mark for dovetail and saw out.

LESSON XXI.

Dovetail (completed).

1. Chisel out and fit the pieces made in last lesson.
2. Drive them together and level off with block plane.
3. Round the ends.

LESSON XXII.

Framing and Wedging.

1. Saw from stock, one piece six inches long, one and one-fourth inches square, and one piece four inches long, one and one-fourth inches square.
2. Square them up.
3. Form mortise three-eighth of an inch by one and one-fourth inches in long piece, using mortise guage and three-eighth inch mortise chisel.
4. Form tenon on short piece, to fit mortise, and to project one inch.
5. Cut hole in tenon, beveled on one side for wedge, using one-fourth inch chisel.
6. Drive together and wedge.

LESSON XXIII.

Squaring to Size.

1. Saw strip one and one-half inches wide from one and one-half inch plank.
2. Gauge the size.
3. Plane with jack plane, and true up with jointer, and try square.

LESSON XXIV.

Planing to Width.

1. Take one-half inch board about six feet long, eight to ten inches wide, and saw off strip four and one-half inches wide.
2. Plane with jointer to four and one-fourth inch.
3. Saw off two pieces eight inches long for sides, and two pieces four and one-half inches long for ends of a box.
4. Square edges and smooth faces with block plane.

LESSON XXV.

Dovetail.

1. Set single gauge to nine-sixteenth of an inch, and square around the ends of pieces prepared in last lesson.
2. Mark for dovetails.
3. Form dovetails, using one-half inch and one-fourth inch chisel, and cutting from both sides.

LESSON XXVI.

Dovetail (completed).

1. Finish up and fit dovetails.
2. Glue together and clamp with hand screws, taking care to bring the joints up, and to keep the box square, using try square at every corner.

LESSON XXVII.

Smoothing and Sand-papering.

1. Saw out two pieces five and one-half inches by nine inches for top and bottom of box.
2. Square up edges and smooth faces.
3. Smooth sides and ends of box with block plane.
4. Sand-paper, clean and smooth.
5. Level off top and bottom edges.

LESSON XXVIII.

Nailing.

1. Nail on top and bottom pieces with one and one-fourth inch 16 wire nails, being careful to drive the nails straight and in the center of thickness of sides and ends.

Molding.

2. Get piece forty inches long, seven-eighths inch square, from stock.

3. Square to five-eighths of an inch, and quarter round with jack plane; making a molding for bottom of box.

4. Get from stock, piece forty inches long, one-half inch square.

5. Square to three-eighths of an inch, and quarter round; making a molding for top of box.

LESSON XXIX.

Mitreing.

Saw molding, made in last lesson, in lengths to fit box (mitreing the corners in mitre box), and glue them on the box.

LESSSON XXX.

Beveling.

1. Plane the edges of the top and bottom of box with block plane to an equal projection all around.

2. Mark the top, with single gauge, one inch on, and one-fourth inch down.

3. Bevel with one and one-fourth of an inch chisel and finish with block plane, and sand-paper block.

LESSON XXXI.

Chiseling.

1. Cut a whole exactly in center of top, one and three-fourth of an inch long, one-eighth of an inch wide. Using one-eighth of an inch chisel.

LESSON XXXII.

1. Finish up the box, with moldings, etc., according to individual fancy.

Drawing.

The character of the work done in drawing is shown in the following extract from the superintendent's report for 1888:

Much has been said and written of late on the wisdom of leavening public education with certain forms of industrial training. As the value of this departure is to be determined by actual experiment rather than by argument it is only necessary here to state what has been attempted the past year.

Interest in this department has been well sustained. Considerably more attention has been given to object drawing in all grades than formerly. The study of exact forms through the sense of sight and touch is made the basis of this instruction. Through clay molding, paper cutting and folding and designing, ideas gained from models are realized by actual making, and so a foundation is laid for all future industrial training.

In the higher work in free-hand drawing the element of construction, representation and decoration are taught. It is found that pupils take pleasure in representing familiar objects. The more drawing is taught as a form of expression and applied in connection with all branches of instruction the more educational it will become.

The aim of the course of instruction in mechanical drawing has been to develop the power of mentally picturing objects in space, and to enable the scholar to express his conceptions on paper with clearness and accuracy. Any one who is familiar with the use of working drawings will recognize the importance of each of these points.

In order to drill the scholars in accurate habits and in the proper use of their instruments the course was commenced with a few simple geometrical exercises, to be drawn with the triangles and compasses, as for example:

To draw a straight line perpendicular to another (a) *through a point on the line*, (b) *through a point without the line.*

To draw an arc of a circle of given radius, tangent (a) *to two other arcs*, (b) *to a straight line and an arc of a circle.*

In every exercise dimensions were assigned which the scholars were expected to follow minutely, and the drawings were frequently tested and compared with the scale.

These primary lessons were followed by instruction on the *plans* and *elevations* of solids, such as the square and hexagonal pyramids, and the cone, and the pupils were taught by simple methods to construct and to represent on paper the coverings or *envelopes* of these solids.

At this stage of the work the scholars were thrown on their own resources and were required to work from dictation, without any assistance from copies or models, such exercises as the following:

Draw the plan, elevation and envelope of (a) *a square prism ;* (b) *a cube ;* (c) *a cylinder ;* (d) *an hexagonal prism in different positions and inclined at different angles according to given dimensions.*

These simple geometrical solids were constructed in cardboard by each scholar, who was thus familiarized with the forms in detail and was enabled to see clearly the connection between the representation on paper and the object in space.

The remainder of the course included instruction in section drawing, illustrated by solid and hollow objects: in finding the envelope or form in the flat of a piece of flexible material, bent into the shape of an elbow pipe, in constructing the helix or curve of the screw ; in finding the intersection of (a) two cylinders, (b) a cylinder and a prism, and the scholar was taught how to construct the curves of intersection of pipes of different forms and proportions.

A short series of lessons has also been given in oblique or pictorial projection drawing, by means of which the form of an object is more

readily understood than by the plan and elevation. Its use is somewhat analogous to the more complicated perspective drawing. The three dimensions of the object to be represented were given and the scholar was required to combine them in one view. The application of this method of representation to practical work will appear when, during the ensuing year, the scholar is called upon to draw the examples of joining work which he executes in the manual training school. Further lessons will be given in the different methods of joining, such as mortising, dovetailing, etc., etc., and the endeavor will be made to maintain a close connection between the drawing, as carried on in the class room, and the practical work which is done in the manual training school."

General Results.

The growth of this branch of training in public favor is indicated from the fact that during the last year, 1888, "two hundred and forty boys have attended regularly and the interest has been good. When these classes were organized a few years ago, some parents questioned the value of this training; there are few but endorse it now. Mr. John Purcell, the instructor, reports that a large number of the boys became proficient in sharpening the tools used. During the last three months of the course, special and useful articles were constructed to the number of two hundred and fifty. A very creditable exhibition of this work was made."

"The excellent work performed by young children in the primary schools," is described in one of the leading newspapers of the city, under date of January 19, 1889, as follows:

"In the rooms of the board of education are on exhibition several boxes of clay work made in the lower primary grades by children between the ages of five and eight years. There are different forms of spheres, cubes, cylinders and prisms, and all are very perfectly molded. There are also representations of various kinds of fruits, and the molding is very true to the natural forms. The idea of drilling these small children in clay molding is to inculcate a basis of the knowledge of form. Thus far this teaching has been very successful and has broadened the observing powers of the pupils. White clay is used. Each pupil is given a small portion, the material being worked into different shapes on a paper laid on the child's desk.

This teaching is intended for the first two years in the primary grades and a portion of the third year. The next higher work is in making the same forms in pastboord and paper. There are also some fine specimens of this work at the executive rooms of the school district. It is intended to select some of the best work in clay and paper to combine with the educational exhibit which will be sent to the Paris exposition. The particular interest is in the fact that such perfect work has been produced by children of such tender years."

IV. FLORIDA.

The Hon. A. J. Russell, State Superintendent of Public Instruction. writes as follows:

"At Jacksonville, October 4, 1887, we built a large two story building on the grounds of the colored graded schools for the purpose of establishing tool-craft training and instruction in the trades, the lower floor for the boys and the upper floor for the girls, employed experienced teachers and fully equipped the school and started the work, which has been most successful so far, sixty finely developed boys and fifty-eight girls entering the school.

This school is in full blast and receives $1,000 a year from the Slater fund in support of it.

During the last summer we built a commodious building—'Mechanic Arts Hall'—on the grounds of the State College, 90 by 45 feet in size, and fully equipped it to training in wood work, with benches, jig and slit saws, lathes and full sets of tools, and October 1, 1888, started it out upon its mission, with every student in college in enthusiastic attendance. Many of the principal schools in the cities and towns have introduced the ordinary tools of the trades and placed a bench and table in the building, and the pupils are being made familiar with their use.

This is our beginning; we hope to press it to the front until we shall make our system of public education thoroughly practical. In our normal schools (State) we are training our teachers of both races for this work when they shall go into the school soon as teachers."

The State of Florida has never legislated on the subject of manual training, but the following regulation, adopted by the State Board of Education, was furnished the Commission by Superintendent Russell:

Regulation 7.—The State Board of Education are deeply impressed with the fact that the large majority of the children in attendance upon the public schools are the children of the poorer people, and will fill the large and important classes of farmers, workmen, mechanics and artisans of the State, and that to impart to them only the knowledge to be derived from the school books, excellent and necessary as it is, will but illy equip them for the sphere of life to which in Providence and circumstances they are very sure to be called, are still more impressed with the necessity of imparting to them some knowledge (to the boys especially) of the useful and necessary tools and implements used in the arts and trades, and to the girls some training in sewing, cookery and housewifery in general, by simple illustrative lectures or talks upon their use, and the general principles involved,

so that a taste may be cultivated for these very useful and important vocations in life, and some knowledge imparted of them, but mainly to impress them with a true and proper conception of the honor and dignity of honest labor. County superintendents and boards of public instruction are urgently and specially called upon to give their earnest attention to this very important feature of school work and instruction.

V. GEORGIA.

1. Atlanta University.

The mechanical course of the "Atlanta University," as laid out in the catalogue of 1887–8, is as follows:

"At present the course covers three years; two of wood-working and one of metal-working. Another year of metal-working will, it is expected, be added soon. It is required of all boys above the third grade, in addition to their regular studies in other courses. Seven and a half hours each week are given to this work.

It is the aim, during this time, to teach the use of tools and the principles of wood-working and metal-working. Those having finished this course who have the ability and the desire to become finished workmen in some one of the trades, will have the opportunity to do so.

FIRST YEAR.

The use and care of the common wood-working tools, as the hammer, saw, plane, try square, gauge, rule, chisel, mallet, bit and brace, bevel, steel square, draw-knife, dividers, screw-drivers.

The general principles of wood working, as sewing, planing, marking, chamfering, boring, mortising, tenoning, halving, grooving, matching, mitreing, beveling, dovetailing, gluing, steaming and bending, driving nails and screws, sandpapering.

Working drawings with steel square and pencil. Measuring lumber.

SECOND YEAR.

Further use of tools and some application of principles in construction.

The use of the wood-turning lathe and jig saw.

First steps in patternmaking.

Glazing.

Mechanical drawing.

THIRD YEAR.

The use and care of the blacksmith's forge and tools, as the anvil hand and sledge hammers, tongs, punches, hot and cold chisels, heading tools, swaging tools, files.

The building and care of the fire, the proper degrees of heat for iron and steel.

The general principles of forging, as drawing, bending, upsetting, spreading, welding.

The tempering of steel.

Chipping and filing to line, gauge and surface. Polishing.
Mechanical drawing, continued."

The course is still incomplete for want of equipment.

The boys of the college, college preparatory and normal courses, and the first two grades of the Grammar School course, take the above course. They are also taught some of the principles of farming and gardening. Attention is given to the raising and care of stock, to the raising of fodder crops, their comparative value and fitness for this soil and climate. The cultivation of vegetables is encouraged by competition and prizes for the best results.

An outfit of type and other printing material has been purchased for the instruction in printing, a press has been recently given, and additions of material will be made as funds allow."

The building for the use of the mechanical department was erected by private subscription, in 1884.

It is of brick, one hundred by forty-four feet and three stories high. One room, forty by fifty feet, is furnished with thirty cabinet benches, each fitted out with the following tools: Rip saw, cut-off saw, panel saw, back saw, compass saw, claw hammer, hatchet, mallet, jack plane, jointing plane, smoothing plane, block plane, four paring chisels, two mortising chisels, six bits and countersink, bit-brace, rule, steel square, try square, bevel, dividers, gauge, drawknife, spoke shave, screw drive, brad awl, nail-set, oil stone and oil can.

In another room are twelve wood turning lathes, run by steam power. More machinery has been added the past year for wood-work. An addition for a forge room has recently been erected, and twelve forges and anvils have been in use during the present year.

A large room has been fitted up for the mechanical drawing, and has been in use since January, 1888, the furniture having been made by the students, as most of that in the building has been."

2. Georgia School of Technology.

The following extracts from the "Act to establish a technological school," will show the purpose and general plan of the Georgia School of Technology at Atlanta.

* * * "That there shall be established, in connection with the State University and forming one of the departments thereof, a technological school for the education and training of students in the industrial and mechanical arts.

* * * "That there shall be one beneficiary for each representative in the General Assembly from every county in this State, selected by the board of education in each county on competitive examination, and who shall be first entitled to the benefits of said school; that the tuition in said school shall be free to all students who are residents of the State of Georgia. The rates of tuition to others than residents of the State shall not exceed one hundred and fifty dollars per annum."

In conformity with this act of the Legislature, the leading object of the school is to teach the principles of science, especially those which relate to the mechanic and industrial arts.

The school was formerly opened October 5, 1888, with ninety-five young men in attendance. The following extract from the opening address delivered by the superintendent of the machine shop, indicates the purpose and methods of the school more in detail. (The references to the Worcester, Mass., shops show the kind of institution taken as a model for this school.)

"The method here will be simple and direct. We aim to place the student, during his course of training here, in an environment not unlike what he may expect to find when he enters the active duties of life.

First of all we recognize the shop as a means of education, training, even culture. This is the highest object of the shops in any school of this character. The friends of this school do not ignore the intrinsic value of the skill attained in the shops, but as valuable as this is, the greatest value of shop training to the man and to the engineer is the marked effective influence upon the mind and character of the pupil. It has been shown that most of the active, managing men of a city are men whose boyhood has been spent on country farms. Now, there is no virtue necessarily in farm work or country life, except that the individual is brought into close contact with things. They meet and overcome many difficulties, and this experience develops sound judgment and ability to manage affairs in a most remarkable manner. This developing influence upon the character is exactly what the shops of a technological school accomplish.

It follows then—if difficulties overcome, educate and develop—we must have a real shop, where real difficulties are overcome, and where real successes are achieved. A play shop cannot do it. A productive shop is a complicated affair. It is a new condition in a school and demands special methods. The shop and its methods must be real, alive, effective. All the men in the shop must be working men, devoting all the business hours of the week to productive work, the same as in other shops. They are all there as teachers of what they know, but their teaching is largely by example with such explanations as may naturally go with their work. All the shopmen may understand that the object of the shop is educational, but, in order that sound business may be taught and illustrated, every effort must tend to economical production.

The plan of operating the shop is as follows:

The Georgia school shops recognize that their object is educational, first and last. This is not a trade school. It is more. It aims to make mechanical engineers, manufacturers, managers of industrial works of all kinds. It will teach a trade, *i. e.*, it will develop manual dexterity because that is a most desirable and necessary step up to the end

sought. It may produce journeymen, if you please, not as the end of the training, but the education of the engineer should include, to some extent, the experience that the journeymen possesses, the accuracy of the machinist, the skill of the patternmaker and the special knowledge of the blacksmith and foundryman. And we believe there is no way so sure, so good and so simple to realize these possessions as to enter the ranks and learn them as if future success depended upon the narrow knowledge of these trades alone.

We, therefore, aim to have the education of the students lead up through these steps so that if a boy starts with a class of a hundred to master all that would make him a successful engineer or manager of larger industrial interests, and he fails to attain his full object, that whatever be the cause of his failing of high leadership, his education at this school shall not be by any means a failure. Dexterity in any art or trade is a step to something higher. Whoever stops at one step has the dexterity that is as valuable to him and more so than if he had started in life to learn the trade only. There are many things to prevent all in a class of a hundred from being eminent leaders in mechanical pursuits. Of course, there is always room at the top, and, thank God, there is room all the way up from the man who knows well what he knows and can do it well.

In starting a class of young men in the Worcester shops it is my practice to show them first that they must very soon find within themselves a love and respect for their calling. They are taught at once that nothing is more promising of reward and honor and success than the pursuit of science, of mechanics and the industries; and the school of technology is not a rival or a substitute for the college; that professional men, our statesmen, professors, lawyers, doctors and ministers have all been held in honor justly, because of their training, because of their characters and because of their culture, and thus they have made their professions honorable. Now, the time is at hand when a mechanical engineer, a manufacturer, has every need and every inducement and every facility for obtaining all that makes any man worthy of the esteem of his fellows, viz: education in its truest sense.

We teach them at Worcester not to be disappointed or discouraged if at first there is a failure to find much love in the chosen work, but such a love can and must be developed. A loving, devoted dwelling upon the beauties of mechanical science is as possible and necessary to the successful mechanic or engineer as devotion is in any profession. They are taught at once that there is no conflict between practice and theory; none at all. Education is as desirable and possible in one pursuit as in another, though it may be of a very different sort.

At Worcester we receive into the shop each year about thirty pupils, at an average age of eighteen to nineteen years. They remain three and a half years. After the first month they are in the shop only two half days per week, *i. e.* ten hours per week during term time.

After about two months they are put at productive work, and sometimes much sooner. We are ever holding more strongly to the method of productive work as a means of education. At the end of the course of three and a half years, our graduates have enough practical shop instruction to compete with young men who have devoted three years entirely to the learning of a trade, and in addition they have the advantages of their scholastic education."

Candidates for admission to the apprentice class must be at least sixteen years old, must be of good moral character and must pass examination in the following studies, viz:

Arithmetic, including elementary principals, fractions, compound quantities, percentage and interest, and proportion.

English, including grammatical construction of sentence, compositions of letters showing proficiency in spelling, punctuation and division into paragraphs.

Geography, particularly that of the United States.

History of the United States.

Candidates for admission to advanced classes must be of relatively proper age, and must show that they are qualified to enter the class for which they apply, either by certificate of work done at other institutions or by examination.

There is no charge for tuition to residents of the State of Georgia. All others pay a tuition fee of $150.

Every student, of whatever place of residence, pays an annual fee of $20 dollars to cover contingent expenses.

A contingent fee of $5 is required to be deposited with the treasurer on entrance to cover injury done to college buildings or furniture, which sum is returned to the student on leaving college, if not forfeited.

Books, stationery, drawing material and drawing instruments are estimated to cost about $25 the first year, and from $5 to $10 per year thereafter.

The departments of instruction include English language, drawing, mechanical engineering, physics, chemistry, geology and mineralogy.

The school offers an education of high grade, founded on the mathematic, the English language, the physical sciences and drawing, while it gives such familiarity with some industrial pursuits as will enable the graduate to earn a living.

There are no elective courses, each student being required to follow the prescribed course, both mechanical and scholastic. The time and attention of students are duly proportioned between scholastic and mechanical pursuits, and special prominence is given to the element of practice in every department.

To thorough supervision and instruction in handicrafts are added the stimulus of protection for the market and such other conditions

as are likely to be met with in the active business of life. Students do not receive money compensation for their work.

Instruction is given by recitations, lectures and practice. Recitations are an hour in length, and classes are so divided into sections as to give equal advantages to all members, and so as to insure faithful performance of duty.

Practice is given in physical and chemical laboratories as well as in the work shops. Students are required to take notes and undergo examinations on lectures.

The following is the scheme of work in detail (the figures indicate hours per work):

Apprentice Class.—Mathematics, 5. English, 5. Free Drawing, 5. Elementary Mechanics, 2. Physics and Chemistry, 2. Practice, 20.

Junior Class.—Mathematics, 5. English, 5. Chemistry and Mineralogy, 5. Physics, 3. Free Drawing, 2. Mechanical Drawing, 5. Practice, 10.

Middle Class.—Mathematics, 5. English, 5. Physics, 5. Mechanical Drawing, 6. Practice, 10.

Senior Class.—Mathematics (first half year), 5. Applied Mechanics, 5. Physics, 5. Chemical Technology, 3. Practice, 10.

The workshop is of brick, two hundred and fifty feet long by eighty wide, and two stories high. It is beautifully designed with reference to its use, and affords ample space for the various departments of instruction pursued in it. It contains boiler and engine rooms, wood-shop, machine-shop, forge room and foundry.

VI. ILLINOIS.

1. Beardstown.

The superintendent of public schools, Beardstown, Ill., has kindly sent the Commission a copy of his "Report of Work in Manual Training," made to the State Superintendent. It covers so many points that we give it entire:

"Our work in manual training may be classed under the following heads:

"1. Primary 'busy work,' which consists in manipulating different forms of matter as splints, paper, clay, sand, etc.

"2. The constructing of relief maps and the modeling of various other forms.

"3. The making of geometrical and other figures to be used in the study of mathematics. These figures are made from card-board and wood.

"4. The constructing of simple apparatus to be used in the study of physics.

"5. Industrial drawing which is taught in all departments of the school.

"6. Shop work, which embraces at present wood-carving, joinery, and scroll-work We hope soon to add lathes for wood-turning.

"As the first five points differ but little from the work of many schools, and since it is common to think of manual training only in connection with tools and shop work I will speak more especially of this part of the work. At the beginning of the fall term '87 the board of education furnished one of the basement rooms with benches and wood-working tools. A teacher was employed to give instruction to classes of boys in wood-work, devoting half his time to it. We have now entered upon the second year with this work. The shop is furnished with six cabinet benches, two vises to each and two sets of tools for each. Four classes of boys selected from the seventh and eighth grades and numbering about fifty, do the work of the shop.

"Two classes work each day about one hour each, the classes alternating so that each class works an average of two and a half hours per week. The department is now in charge of Mr. J. N. McQuilkin, a graduate of the St. Louis Manual Training School. As observed above, the instructor devotes but half his time to the shop work, the remaining time being devoted to teaching other branches, principally arithmetic and drawing. The purpose of the shop work is to train boys to a systematic use of wood-working tools. To effect this, exercises are given in the use of the plane, saw, square, hammer, chisel, gouge, brace and bit, and a few other tools. Draw-

ings are first made by the pupil, and he works carefully and accurately from these. Aside from the simple apparatus, geometrical forms, etc., mentioned above, each pupil is allowed to complete some given article during the term; but the work consists chiefly of exercises designed to develop mathematical and mechanical skill, and to train to a right use and care of the tools.

PURPOSE.

"In addition to what has already been indicated concerning the purpose of the manual training, I may add that it is not the purpose to make mechanics, or even to impart very much or very superior mechanical skill. Our course of study is designed to embrace two years shop work.

"The same considerations which have induced school boards in many places to adopt the use of tools and shop work, led our board to make the experiment. It may not be out of place here to give a synopsis of these considerations.

"1. Boys in the higher grammar grades become restive, tired of school, and manifest an irrepressible desire to be doing something outside of school. It was hoped that the interest and variety of half an hour's shop work each day would satisfy this desire and hold the boys for a longer time in school.

"2. Since it is the purpose of education to develop all the powers of mind and body, it was thought that practice with tools would develop the constructive talent which at the age referred to is struggling to free itself. It was further believed that germs of talent might in this way be discovered that might otherwise remain hidden.

"3. Since the law of action and reaction applies in mental as well as physical forces, it was believed that the work of the regular curriculum would be both quickened and strengthened by vigorous thinking and doing—*i. e.*, by planning and executing some material thing.

"4. The above considerations were supplemented by an economic view. The advantage to every person, whatever his station or vocation in life, of being "handy" with tools was deemed sufficient to justify the introduction of tool work.

"5. A more far-reaching, economic view was the one frequently urged by magazine writers and advocates of manual training generally, namely, that it is the business of the school to counteract as far as possible the too prevalent and growing idea that physical toil is degrading to manhood; that to be educated is to be able to earn a living without soiling the hands, etc.

EXPENSE.

"The following statement will show approximately the cost of inaugurating and carrying forward the work:

6 Cabinet benches,	$100
12 Sets of tools,	50
Additional tools for general use,	15
Fixtures and furniture,	25
Incidentals,	10
Total,	$200

Annual cost of carrying on the work:

Instruction,	$250
Material,	25
Repairs,	15
Incidentals,	10
Total,	$500

RESULTS.

"We have hardly been at work long enough to speak of results. Accuracy, patience, and a quickening of the observing powers are noticeable, however. The teachers affirm that the boys who do this work are *more proficient in arithmetic, drawing, and in orderly and systematic arrangement of work than those who do not.* Improvement in individual cases has been observed in the above respects, after taking up the work.

"The attendance of boys has been considerably increased in the upper grades since the introduction of the shop work. Other causes have doubtless contributed to this, but it is fair to conclude that the manual training has contributed its share.

"A few boys, who are exceedingly dull in the other work, are among the best in drawing and shop work. The reverse is also true. Again, others who are excellent in the regular work excel also in this.

"I may add that, as yet, we have nothing corresponding to the shop work for girls. We have agitated somewhat the subject of plain sewing and textile work, but have done nothing definite in this direction.

The work that we are doing is enjoyed very much by the boys, and, *though the work is optional, all the places are full and we cannot supply the demand for opportunities to work.*

"We are satisfied with the experiment; it meets with almost universal favor on the part of patrons and citizens." [The italics are ours.]

2. Chicago Manual Training School.

The Chicago Manual Training School was founded by the Commercial Club of Chicago, the necessary funds being subscribed March 25, 1882.

The object of the school, as stated in the articles of incorporation, was "instruction and practice in the use of tools, with such instruction as may be deemed necessary in mathematics, drawing and the English branches of a high school course, it being the intention to divide the working hours of the students, as nearly as possible, equally between manual and mental exercises."

Candidates for admission to the junior year must be at least fourteen years of age, and must pass a satisfactory examination in reading, spelling, writing, geography, English composition and arithmetic.

"Before entering this school boys should be able to spell correctly words in general use, to punctuate properly, and to express themselves in good English. They ought to have formed the habit of consulting dictionaries and other reference books, so as to be able readily to extract an author's meaning from a page of ordinary English. They ought also to be familiar with the fundamental operations of arithmetic as applied to integers, fractions, denominate numbers, including simple measuration and percentage."

Pupils desiring to study Latin must pass a special examination in English grammar. Boys who have completed a grammar school course should have no difficulty in passing the examination for admission.

The full course of study, covering three years, is as follows:

JUNIOR YEAR.

1. *Mathematics.*—Algebra, Geometry.
2. *Science.*—Physiology, Physical Geography.
3. *Language.*—English Language and Literature or Latin.
4. *Drawing.*—Free-hand, Model and Object, Projection, Machine, Perspective.
5. *Shop Work.*—Carpentry, Joinery, Wood-Turning, Pattern-Making, Proper care and Use of Tools.

MIDDLE YEAR.

1. *Mathematics.*—Geometry, Plane Trigonometry.
2. *Science.*—Physics.
3. *Language.*—General History and English Literature or Latin.
4. *Drawing.*—Orthographic Projection and Shadows, Line and Brush Shading, Isometric Projection and Shadows, Details and Machinery, Machines from Measurement.
5. *Shop Work.*—Molding, Casting, Forging, Welding, Tempering, Soldering, Brazing.

SENIOR YEAR.

1. *Mathematics.*—Mechanics, Book-Keeping.
2. *Science.*—Chemistry or Descriptive Geometry and Higher Algebra.

3. *Language, etc.*—English Literature, Civil Government, Political Economy, or Latin, or French.

4. *Drawing.*—Machine from Measurement, Building from Measurement, Architectural Perspective.

5. *Machine Shop Work.*—Chipping, Filing, Fitting, Turning, Drilling, Planing, etc.; Study of Machinery, Management and Care of Steam Engines and Boilers.

The student is not only taught the *use* of tools, but "instruction is given each year in the production, properties and uses of the materials—wood, iron, steel, brass, etc.—used in that year.

"Throughout the course one hour each day is given to drawing and two hours each day to shop work. The remainder of each school day is devoted to study and recitation. A diploma testifying to scholarship and skill is given on graduation. To those who have not satisfactorily completed the three years' course are given certificates of proficiency in whatever departments of study and practice their work has reached the required standard. These certificates are exchangable for diplomas whenever the full course shall have been finished to the satisfaction of the school authorities. Certificates are given only to pupils who have been three years in the school, and who have been prevented by ill health, or other unavoidable cause, from completing the course. Boys are not admitted to partial courses.

"To meet the requirements of different technological schools which graduates may desire to enter, pupils are permitted, with the approval of the directors, the choice of Latin and French instead of the English language and literature, and descriptive geometry and higher algebra instead of chemistry.

"Upon the recommendation of the director, graduates of this school are admitted without examination and free of conditions to the School of Mechanics and Engineering of Purdee University, Lafayette, Ind; the Polytechnic School of Washington University, St. Louis, Mo.; Sibley College, Cornell University, Ithaca, N. Y.; Rose Polytechnic Institute, Terre Haute, Ind."

In the awarding of prizes, equal importance is attached to scholarship, drawing and shop work—three being offered for each, and one prize to the member of the graduating class who has maintained the most satisfactory record in every respect during the entire course of three years.

In addition to lectures given in connection with the regular courses, several series on American history have been planned "with the design of cultivating a patriotic and law-abiding spirit as one of the foundations of good citizenship."

In judging of the results of the work it is to be borne in mind that "education not manufacture is the idea underlying the manual training." The exercises are therefore chiefly "designed to develop skill in the use of tools, but, "the educational value of construction is

also recognized, and the course embraces a number of finished articles."

Some idea of the pupils' work during the year 1887–8 may be gained from the following list:

WORK DONE IN THE WOOD ROOM.

(*a*) *Carpentry.*

96 exercises in planing and sawing.
864 exercises in joinery, including tongue and groove joints, mortise and tenon joints, square and oblique dovetail joints, dovetail scarf joints, keyed scarf joints and frames with keyed mortise and tenon joints and braces.
672 small drawing models, including triangular square, pentagonal and hexagonal frames, cubical frame, double cross, etc.

(*b*) *Wood-turning.*

600 exercises in soft wood giving practice in roughing down, straight paring work, concave and convex curves, Vs, beads, etc.
648 exercises in hard-wood turning.
144 hard-wood tool handles.
96 hard-wood rosettes.
200 white maple dumbbells.
144 turned moldings for cabinet work.
1 globe and stand.

(*c*) *Cabinet Work.*

192 exercises in drawer dovetails (front and back).
24 chalk holders for school room.
216 exercises in mitered ornamental picture frames.
4 large drawing models.
24 fancy work boxes.
4 ladies' work tables.
2 book-cases for school rooms.
5 revolving book-cases.
1 center table.
2 pedestals.

(*d*) *Pattern-making.*

48 patterns of hexagonal wrench.
48 patterns of journal brass.
96 patterns of square grate.
24 patterns of building braces.
48 patterns of quarter turn and half turn flanged pipe with case boxes.

MIDDLE CLASS—SCHOOL YEAR 1887–8.

Forge Department—Exercises.

Preparatory in lead,	240
In Iron.	
Drawing,	135
Upsetting,	130
Bending (rings and links),	183
Gate hooks,	65
Double hooks,	66
Pointed eyebolts,	62
Staples,	130
Chain locks,	61
Nails,	250
Bolts, square and hexagonal,	140
Nuts, square and hexagonal,	125
Welding, fagot lap, and "T" welds,	248

Rings, band and flat or washer,	133
Rings and eyebolts,	130
Chains, hooks, links, swivels and rings,	630
Shelf brackets,	65
Angle or corner braces,	66
Blacksmith tongs,	95
Fire shovels,	20
Heading tools steel faced,	40
Wrenches for wood lathes,	16
Exercises in brazing and sweating,	40
	3,070

STEEL FORGING AND TEMPERING.

Tools all Cast Steel.

Cold chisels, flat,	60
Cape chisels.	30

For Woodwork.

Firmer chisels,	12
Socket chisels,	2
Turning chisels,	3

Lathe Tools.

Diamond point, square and round nose front side tools (right and left), thread and cutting off tools and inside or boring tools; also reamers and drills; in all,	65

Hammers.

Balle pene, cross pene and claw hammers, in all,	18
	180

Extra.—Pipe tongs, gas pliers (steel), pincers (steel), screw-drivers, scratch awls, center punches, magnets, fencing foils, horse shoes, forgings for engines, bolts, cut off rods, straps and keys and forgings for thirty-two jack screws.

Projects.—3 hall lamps, 4 piano lamp stands, 2 dictionary stands, 1 flower stand and grate rack with poker, tongs and shovel.

Steal Tools for Shop Use.

7 flatters, 8 set hammers, 4 chisels (handle), 4 bottom fullers and 1 eye punch.

FOUNDRY WORK.

Melting in Soft Metals.

Molding parts of speed lathes and engines, hangers for shaftings (including boxes and oil cups), pulleys, shearer pulleys, gears, bevel and mitre, washers, nuts, wrenches, valves, swivels, ornamental patterns, etc.

WORK DONE IN MACHINE SHOP 1887–88.

By Senior Class.

74 exercises, chipping and filing.
74 exercises, filing, boring and turning.
74 exercises, lathe work and filing.
62 exercises, planing and filing.
6 taps.
2 reamers.
9 tools for making engines.
6 eight horse-power steam engines.
40 jack screws.
12 tile breakers.
2 bench screws.

2 wood room vises.
2 wood room spurs.
1 Counter shaft.

Projects:

4 six horse-power steam engines.
1 small steam engine.
1 wood lathe.
2 dynamos.
2 cameras.
3 set taps and dies.
1 grindstone, frame, shaft, etc.
1 electric motor.

WORK IN DRAWING.

Junior Class.		
Drawings,	3,588	
Sketches,	1,748	
		5,336
Middle Class.		
Drawings,	520	
Sketches,	1,235	
		1,755
Senior Class.		
Drawings,	144	
Sketches,	360	
		504
Total,		7,595

The first-class was organized February 4th, 1884, and was graduated June 24th, 1886.

The following extracts from reports of committees chosen from the architects and manufacturers of the city to examine and report upon the character of the work done by this first class, will show how practical business men looked upon the results obtained.

"Since our examination of the work on view was expected to be general, we can only express ourselves in general terms; and yet it seems that we should particularize somewhat, where drawings are so deservedly meritorious. The work of free-hand drawing, and drawing from the round, include some very clever productions, which older draftsmen than those who made them might well be proud of. The careful drawing of the locomotives, from actual measurements, are deserving of attention and praise. There are specimens in mechanical drawing, both geometrical and perspective, which are admirable, while some of the architectural drawings presented are of superior character. The line-drawing of the elevation of a residence, the perspective of another, the production of scale-drawings, from actual measurements of the Manual Training School Building, and the perspective drawings of the same building, all indicate careful study from careful training. There seemed to be less careless handling and poor drawing exhibited, for the number displayed, than is usual in older schools and in larger institutions.

"We are pleased to extend our congratulations upon the success so far attained by your institution, which we hastily visited in detail after the examination of the drawings; and we believe the work which you have inaugurated here will develop into one of the strong arms of education, and will be a powerful agent for good in the future, in the development of skilled and educated mechanics.

"These schools in the future, we believe, will break down the society lines, which all, or most all, building-trade societies have fenced themselves in with, and will assist to send out able and skilled artisans in the building trades, regardless of their laws and edicts, and will also tend to so elevate the industrial arts to a degree that many a young man may be proud to be known as a *mechanic.*"

"DEAR SIR: Responding to the request of Mr. H. H. Belfield, I inspected the wood-work of your Junior class, consisting of turning, sawing, moldings, carving, dove-tailing, jointing, framing and construction; and I am pleased to bear testimony to the work being a credit both to the pupils and their instructors—comparing very favorably with that done by many who profess to be finished mechanics; which goes to show very plainly that the education in the use of mechanical tools cannot begin too early in life to make the perfect workman."

"Your committee, who were requested to examine and report castings, etc., made by the pupils in the institution, would respectfully report that we have examined various samples of work done, and that we take great pleasure in assuring you that we are agreeably surprised at the evidence of skill manifested in the work done. Considering the age of the pupils and the time given to the manipulation of tools, the progress is remarkable, and shows great skill and aptitude in the forming and shaping of articles from the various metals."

The following extracts from a letter to the Commission from the director of the school, under date of October 3, 1888, briefly states the present situation:

"I scarcely know what more to send [than catalogues] that will interest you. Possibly the enclosed list of the articles made by the pupils last year may serve some purpose.

I may also state that our school takes its full share of prizes at the State fair, for scholastic work, in competition with the scholastic work of the best high schools of the State. I think this important, as showing that the manual work does not interfere, or retard the purely academic work.

In regard to the attitude of the public towards our school, and manual training in general: The school was opened with considerable doubt of its ability to do fair intellectual work, especially among educational people. That doubt has been largely dissipated. The general public has welcomed our work from the first, though it has had misconceptions of the true character of our scope. Many imagined the school to be a refuge for the dunces or scape-graces that could make no progress in, or were wisely expelled from the public school. Many supposed it to be a school for the teaching of trades. But its true character has forced itself on the minds of people generally; and the number of applicants for admission has steadily increased. Our first class numbered 78; the present junior (first year) class numbers 102, and I am refusing applicants almost daily, simply for want of room.

Last year the entire school—three classes—was 202; this year, 225.

There is a demand for teachers of manual training, especially in colleges and private schools. A letter from the Texas State Agricultural and Mechanical College is just received, asking for a teacher. One of my graduates taught last year in the Arkansas State College at Fayetteville, and this year has gone to the Miller school, Virginia. Another taught a private school in Racine, during July and August.

During the school year several of my pupils teach manual training on Saturday."

Very truly yours,
(Signed) H. H. BELFIELD.

3. Peru, Ill.

"Manual training is in its sixth year here, with no abatement of interest; rather a settled content that it is a part of our public school system. With us it has received attention in three directions:

1. The boys' workshop for wood work, fitted up for classes of twenty with all the tools necessary for such practice. The boys take this work daily except Friday forty-five minutes each recitation. In these classes are taught (*a*) care and use of tools, (*b*) nature of materials to be used, (*c*) practical designing of simple objects.

2. For the girls, sewing. In this department only plain sewing, cutting and fitting is attempted. There is no work being done in this department now, though we shall have some for our winter classes.

3. Wood-carving at school seats in connection with drawing lessons.

This in brief constitutes our manual training work."

Yours truly,
(Signed) R. L. BARTON,
Superintendent City Schools.

4. Illinois State University.

"The State University of Illinois, had its origin in a movement for the higher education of the industrial classes, begun in 1851, and resulting in the congressional grant of lands for this purpose, made to the several States in 1862, and amounting in this State to 480,000 acres. The university was chartered in February, 1867, and opened to students in March, 1868. Successive colleges and schools have been added as required, until four colleges, including ten distinct schools, have been organized."

Applicants for admission to the mechanical engineering course should be at least eighteen years of age—none are admitted under fifteen—and must pass examination in arithmetic, geography, English grammar, history of the United States, algebra through quadratics, physiology, natural philosophy, plane and solid geometry, and botany.

EXPENSES.

The tuition is free in all the University classes.

The matriculation fee entitles the student to membership in the University until he completes his studies, and must be paid before he enters; amount, ...	$10 00
The term fee for incidental expenses is, for each student, . .	7 50
Room rent in university dormitory, each student per term,	2 00 to 6 00

Each student in the chemical and physical laboratories, and in the draughting and engineering classes, is required to make a deposit varying from fifty cents to eight dollars, to pay for chemicals and apparatus used, and for any breakages or damages.

All engineering students pursue the following studies: French or German for two years; pure and applied mathematics, physics and drawing. The special work of the mechanical engineering students will be best understood from the following extracts from the annual catalogue:

SCHOOL OF MECHANICAL ENGINEERING.

Object of the School.

This school seeks to prepare students for the profession of mechanical engineering. It aims to fit them to invent, design, construct and manage machinery for any branch of manufactures. The State needs men who, to a thorough knowledge of the principles of machinery and of the various motors, add the practical skill necessary to design and construct the machines by which these motors are made to do work.

Instruction.

The instruction, while severely scientific, is thoroughly practical. It aims at a clear understanding and mastery of all mechanical princiciples and devices. Practice in the mechanical laboratory is counted as one of the studies of the course.

In *principles* instruction is imparted by lectures, illustrated plates, and by text books. Examples are given showing the application of the theories and principles taught. Experiments in the testing of machines and motors are undertaken by the student.

In *practice* elementary forms are produced and projects are executed in which the student constructs machines, or parts thereof, of his own designing, and from his own working drawings.

In *designing* the student begins with elements, and proceeds with progressive exercises till he is able to design and represent complete machines.

Mechanical Art and Design.

An elementary course of shop practice has been carefully arranged to familiarize the student with the forms of the parts of machines and the mode of producing them. He is made familiar with all the ordinary cutting tools for iron or wood, with the form and condition for most effective work, with the machines and appliances by which they are put in action, and the instruments by which desired dimensions of product are obtained. This practice is obtained in the mechanical laboratory and represents four different shops, viz:

1. Patternmaking.
2. Blacksmithing.

3. Bench Work for Iron.
4. Machine Tool Work for Iron.

In the first the practice consists in planing, turning, chiseling, etc., in producing true surfaces in various forms in wood, and also in combining pieces of glue joint, etc., preliminary to correct patternmaking. Patterns are finally made, from which are cast pieces in iron, brass, etc., to be worked in the subsequent shops.

In the second, the student uses the forge and performs the various elementary operations; such as drawings, upsetting, bending, welding, etc.

In the third there is first a course of free-hand bench work, the cold chisel and file being the only tools. After the hand and eye are sufficiently trained, fitting is begun, and the square, bevel, rule, compasses and other auxiliary bench tools are used. Pieces are then fitted together by the file, with surfaces carefully finished.

In the fourth shop the ordinary machine tools of the machine shop are used. The first practice employs these machines with their cutting tools or bits, in common operations, such as turning cylinders, discs, grooves, and fillets; boring, drilling, hand-turning, milling, planing, etc.

Following this is a course of practice in fitting and finishing, in which calipers, rules, etc., are introduced, and many of the various fittings employed in machinery are produced.

Lectures are given in which the most favorable forms and manipulations of cutting tools and auxiliary appliances are explained.

Previous to the shop work, drawings of the pieces are made by the student, and the exact thing to be done is indicated; thus mistakes are avoided and practice facilitated.

The designing of such machine elements as pulleys, journal boxes, cranks, stuffing boxes, etc., cultivates a knowledge of proportion, and of its proper representation on paper.

This course of elementary practice fits the student for the advanced shop practice in designing and construction of complete machines undertaken later in the course.

TECHNICAL STUDIES.

Kinematics and Principles of Mechanism.—Relative motion of points in a system of connected pieces; motion independent of force; velocity ratio; investigation of motion of elementary parts of machines, at friction and non circular wheels in rolling contact, cams and curves in sliding contact; gear teeth; gearing chains; escapements; link work.

Prime Movers.—The theory and useful effects of turbine water-wheels, and best form of the parts for high efficiency. Other water-wheels and wind-wheels. Application of the thermo dyamics in the study of heat engines. Relative economy of different engines.

Mill-Work and Machinery.—Trains of mechanism studied with reference to their resistance and efficiency; best forms for transmission of power for short or great distances; forms of the parts for securing desired results in power and velocity; elastic and ultimate strength of parts.

Machine Drawing.—Working drawings of original designs; finishing in water colors, and in line shading; details for shop use according to the practice of leading manufacturers.

PROJECTS AND PRACTICE.

"The shop practice of the first year has already been described. The second year practice has for its object the production of some model or machine. The students, under the immediate direction of the teachers, carefully determine the dimensions and shapes best suited for the parts of some machine, produce them in neat and accurate working drawings, and make tracings for shop use. No student commences his advanced shop practice without working drawings. The designs are such as require execution in iron. brass and wood, for the purpose of giving variety of practice. The student is required to make the patterns and castings, finish the parts, and put them together in accordance with the working drawings and the required standard of workmanship. This acquaints him with the manner in which the mechanical engineer carries his designs into execution, and teaches him to so shape, proportion and dispose the parts of a machine as to secure the greatest economy of construction and durability in use. The practice of the third year includes the careful construction of mechanical movements, strictly in accordance with the theoretical determination of the form of the parts.

"Besides these practical exercises, students of sufficient skill may be employed in the commercial work which is undertaken by the shop. For this work they receive compensation. This work includes all kinds of machine building and repairing, and serves to extend and conform the practical experience of the student.

"*Experiments and Practical Problems.*—Experiments in the testing of prime movers and other machines, are undertaken by each student. They take indicator diagrams from the engine of the mechanical laboratory and in factories in the adjoining towns, and determine from them the power developed with different degrees of expansion, and the possible defects of valve movement in distribution of steam."

APPARATUS.

This school is provided with plates and a cabinet of models illustrating mechanical movements and elementary combinations of mechanism.

The mechanical building and drill hall is of brick, 126 feet in length and 88 feet in width. It contains a boiler room, a machine shop, furnished for practical use with a steam engine, lathes and other machinery; pattern and finishing shops; shops for carpentry and cabinet work, furnished with wood-working machinery; paint and draughting rooms, and rooms for models, storage, etc. An addition for a blacksmith shop, 32x36 feet, contains forges, with anvils and tools, and a cupola for melting iron.

The Mechanical Laboratory is provided with a steam engine, engine and hand lathes, planer, drill presses and the requisite hand tools, benches, vises, anvils, etc., for pattern shop, blacksmith shop, molding room and bench work. Its cabinets contains several hundred models of elements of mechanism and machines.

VII. INDIANA.

1. Indianapolis Public Schools.

Superintendent Jones, of Indianapolis, Indiana, under date of September 27, 1888, writes:

"We have no documents of the kind to which you refer. We are in the midst of our first year of manual training in our high school. We have for many years carried out a systematic course of drawing and construction work throughout our primary schools, but have no printed documents. My annual report, in which I have discussed the subject somewhat, is in the hands of the printer. The public sentiment here is favorable to such course as an educational force, tending to develop executive ability, rather than as an immediate preparation for any special calling."

2. Purdue University.

Purdue University is a State institution. It is supported by legislative appropriations and by the proceeds of the land grant Act of 1862. It derives its name through legislative enactment from John Purdue, who gave to the State for the use of the institution two hundred and twenty thousand dollars. It has a permanent endowment fund to the amount of three hundred and forty thousand dollars, and other non-productive property in buildings, lands and equipment to the value of three hundred and thirty thousand dollars.

It has one hundred and eighty acres of land in its campus and farm, fifteen buildings, well equipped laboratories, shops, museums, library and reading rooms.

Its purpose is to afford the young men and women of Indiana an opportunity to acquire a good collegiate education in mathematics, science, literature and art, and at the same time to secure instruction and practice in such lines of work as will fit them to engage in the practical industries of life. The instruction is both theoretical and practical. The usual methods of text-book study, recitation and lecture are employed, but the student is required to put into practice as far as possible the instruction which he receives. He, for example, not only receives instruction in regard to the theory and principles of drawing, patternmaking and machine construction, but he is required to make working drawings himself, to construct patterns, to make the castings in the foundry, to finish and set up the machine, and to operate it when it is completed. This combination of the theoretical and the practical, characterizes the institution.

Being a State institution, the instruction in Purdue University is free to all residents of Indiana of suitable age and acquirements. Small laboratory, library and incidental fees only are charged.

The instruction embraces six special schools and a preparatory department as follows:

I. *A School of Agriculture, Horticulture and Veterinary Science.*
Leading to the Degree of Bachelor of Science.

II. *A School of Mechanical Engineering.*
Leading to the Degree of Bachelor of Mechanical Engineering.

III. *A School of Civil Engineering.*
Leading to the Degree of Bachelor of Civil Engineering.

IV. *A School of Science.*
Leading to the Degree of Bachelor of Science.

By *elections* in the Junior and Senior years this school may be developed into

(*a*) *A School of Biology.*
(*b*) *A School of Chemistry.*
(*c*) *A School of Applied Electricity.*
(*d*) *A School of Literature and History.*

in which one or the other of these subjects may occupy the greater part of the student's time.

V. *A School of Industrial Art.*
Leading to the Degree of Bachelor of Science.

VI. *A School of Pharmacy.*
Leading to the Degree of Graduate in Pharmacy.

VII. *A Preparatory Department.*

The courses of instruction in the first five special schools are so arranged that they include, with few exceptions, the same instruction in general science, mathematics, English history, political and mental science, and industrial drawing. In addition to these branches common to the five schools, the school of agriculture adds four years of instruction and practice in agriculture, horticulture and veterinary science; the school of mechanical engineering, two years of instruction and practice in practical mechanics and two years of mechanical engineering; the school of civil engineering, five terms of instruction and practice in practical mechanics and seven terms of civil engineering; the school of science, four years in laboratory work in the natural and physical sciences; and the school of industrial art, four years of instruction and training in industrial art.

Students in each of these schools are now required to spend in laboratory, shop or field an average of two hours each day in such forms of handwork as will fit them to engage in industrial pursuits.

Applicants for admission to the freshman class must be sixteen years of age.

Applicants are examined in English (including grammar, the elements of composition, reading and spelling), descriptive geography, history of the United States, arithmetic and algebra through quadratic equations.

Applicants who have completed their course of preparation in high schools, which have been commissioned by the State Board of Education, will be admitted to the freshman class without examination.

Persons desiring to enter an advanced class in the university will be required to give satisfactory evidence that they have done work equivalent to that already accomplished by the class to which entrance is desired.

Advanced students who can give evidence that they have done work equivalent to the language, literature, history and mathematics of our freshman and sophomore years, can take the technical work done in those two years in one year, and thus be enabled to complete any one of the general courses in three years.

School of Mechanical Engineering.

The instruction in this school is arranged to respond to the present strong and growing demand for young men who understand practical mechanical construction, who are skilled in the use of tools, and who have been given such additional and advanced training that they may become, not merely constructors, but also inventors and designers of machinery.

During the first two years, special prominence is given to shop work and the studies pertaining thereto, including instruction and practice in those underlying principles of the common trades, which, when taken together, form a basis for all lines of special mechanical work.

The last two years are specially devoted to the theory and practice of mechanical engineering.

The course of instruction, omitting general and literary studies, is as follows:

FRESHMAN YEAR.

Technical Instruction.—Twenty-seven weeks, three hours per week. Under this head are comprised:

(a). *Lectures* developing the character of cutting edges for wood, the adjustment of different tools and the methods by which they are kept in order; also, lectures on the shrinkage and warping of woods; different forms, adaptation and relative strength of joints.

(b). *Lectures* on wood-working machines, including rotary and traverse planers; circular, scroll and band saws; and lathes and lathe attachments.

(c). *Lectures* on patternmaking, molding and casting.

Mechanical Drawing.—Fifteen weeks, seven hours per week; twelve weeks, four hours per week, and eleven weeks, ten hours per week.

(a). *Model-drawing in outline.*

(b). *Drawings from copy* of the details of machines.

(c). *Drawings* for built-up pulley patterns, pipe bends, laggings, sweeps, patterns for sectional molding and for other work of like character that may be done in the shop.

Shop Work.—Thirty-eight weeks, ten hours per week.

(a). *Exercises* in planing, sawing, rabbeting, plowing, notching, splicing, mortising, tenoning, dovetailing, framing, paneling and in other work involving the common carpenter tools.

(b). *Exercises* in circular sawing, scroll sawing and turning.

(c). *Exercises* in patternmaking, including patterns and core boxes for pulleys, gears, columns and pipe joints; complete sets of patterns for one or more machines are made by every class.

(d). *Exercises* in coremaking, moldmaking and casting; also in the management of cupola furnace and crucible furnace in melting iron and brass.

SOPHOMORE YEAR.

Technical Instruction.—Twenty-three weeks, two hours per week.

(a). *Lectures* on the management of steel in forging, hardening, tempering and annealing.

(b). *Lectures* on hand-tools for metal.

(c). *Lectures* on machines for machine work.

Mechanical Drawing.—Fifteen weeks, five hours per week; twelve weeks, three hours per week; and eleven weeks, four hours per week.

(a). *Drawings* to scale from parts of actual machines.

(b). *Ink-shading and tinting.* The representation of flat and curved surfaces by ink tints, and of engineering materials by colors.

Shop Work.—Thirty-eight weeks, ten hours per week.

(a). *Iron forging,* including exercises in heating, bending, drawing, upsetting, welding, annealing, and case hardening. About forty forgings are made, representing a large variety of operations.

(b). *Steel forging,* including the making and tempering of punches, drills, chisels, machine cutting-tools, gravers and springs.

(c). *Exercises* in vise work in iron, including surface chipping, key-seating, surface filing, squaring and fitting, round-filing, sawing, scraping and polishing.

(d). *Machine work* in metals, including exercises in turning, planing, slotting, drilling, boring, fluting, etc. This practice is given in the construction of complete machines and appliances.

JUNIOR YEAR.

Descriptive Geometry.—Fifteen weeks, ten hours per week. Instruction and practice in the methods of representing, by drawings, all geometrical magnitudes and the solution of problems relating to these

magnitudes in space. This subject, including the principles of shades, shadows and perspective, is taught by lecture, the time allotted being equally divided between instruction in the class room and the practical solution of original problems in the drawing room.

Principles of Mechanism.—Twelve weeks, four hours per week, and eleven weeks, two hours per week. Under this head are studied the principles underlying the action of the elementary combinations of which all machines are composed. The communications of motion by gear-wheels, belts, cams, screws and link-work, the various means of producing definite changes of velocity, different automatic feed motion, epicylic trains, parallel motions, the principles of quick return movements, and the manner of designing trains of mechanism for various purposes, all form part of this subject.

Mechanical Drawing.—Twelve weeks, two hours per week, and eleven weeks, eight hours per week. The work in mechanical drawing is directly supplemental to the instruction in principles of mechanism.

The work includes drawings of epicycloidal and involute gear-wheels, drawings of pin-gearing, bevel gearing, lobed wheels, cams, endless screws, and other elementary combinations. These drawings are not in any sense copies, being made by each student to correspond with data furnished him by the instructor. During the spring term each student makes complete working drawings of some existing machine, obtaining for himself all necessary data by direct measurement from the machine.

Metallurgy.—Eleven weeks, three hours per week. The various fuels and refractory materials are first taken up and their special fitness for different metallurgical operations is pointed out. The characteristics, composition and location of the principal iron ores are next examined, after which all the various operations in the manufacture and refining of iron and steel are explained in detail, according to the most modern practice. See also chemistry, page 42.

Heat.—Twenty-seven weeks, three hours per week. Nature and effects of heat, temperature, measurement of heat, expansion, liquefaction, evaporation, latent heat, specific heat, conduction, convection, relation between heat and mechanical energy, principles of thermodynamics. The instruction will be given partly in the class-room and partly by experimental work in the physical laboratory.

SENIOR YEAR.

Analytical Mechanics.—Nineteen weeks, five hours per week. The work in this subject consists of mathematical investigations concerning the action of forces on solids, liquids and gases

Steam Engine.—Fifteen weeks, four hours per week. The work begins with the study of the general theory of the steam engine and of its efficiency as a prime mover, including discussions of the laws

of thermo-dynamics, the expansion of steam, jacketing, cushioning, action of fly-wheels, effect of clearance, effect of condensation in cylinder and other similar subjects. The relative advantages of simple and compound, condensing and non-condensing engines, the principal types of modern engines, the various valve and cut-off motions, the method of determining the size of an engine to do any required work, and of calculating the sizes of all its parts are all explained. Special attention is given to the steam engine indicator, and the student becomes thoroughly familiar with its use and the manner of interpreting its indications. Each student participates in a number of complete engine tests, determining the efficiency of a given engine under specified conditions.

Boilers.—Six weeks, five hours per week. The various modern forms of steam boilers are carefully studied, noting their advantages and disadvantages and the methods employed in their construction. The number and size of tubes and flues, the thickness of plates, strength of different styles of riveting, kinds of bracing, amount of grate and heating surface, different kinds of steam and water gauges, safety valves and injectors; the causes of and methods of preventing foaming, incrustation and corrosion, the manner of setting boilers and of operating them with safety and economy are all studied in detail. Each student participates in at least one complete boiler test, determining the evaporative power and economy of combustion of fuel of one or more boilers under given conditions, and must also design and draw a boiler of a style and size chosen by the instructor.

Strength of Materials—Six weeks, five hours per week. This subject includes the study of the strength, elasticity, and other physical properties of the various materials of construction, such a stone, wood, cast and wrought iron, steel, copper, brass, etc. Students acquire this information partly from text-books, but principally from actual experiments made by themselves with the powerful testing machine belonging to the testing laboratory. The proper forms for greatest strength under given conditions, as well as the laws governing deflection and elasticity, are deduced by theoretical investigation and verified by practical experiment.

Machine Design.—Eight weeks, five hours per week. During this time exercises are given in the design of simple machines to do given work under specified conditions. The necessary motions are carefully laid out, and the sizes and proportions of the various parts are determined by calculation. Part of the time is devoted to the manner of arranging shops, the means of transmitting power over both short and long distances, and to the solution of some of the miscellaneous problems constantly arising before the mechanical engineer.

Mechanical Drawing and Experimental Work in Engineering.—Thirty-five weeks, ten hours per week. Throughout the senior year students devote two hours daily to practical work in the drawing

room and in the testing laboratory. They make drawings of peculiar and complicated machinery; they also prepare the necessary drawings in connection with the study of machine design; they take part in all the experimental work done by the testing laboratory, including the determination of the efficiency of boilers, steam engines and pumps, the relative value of coals, the strength of the materials of construction, and other subjects of importance to the mechanical engineer.

Applied Electricity.—Thirty-five weeks, six honrs per week. The work in this subject includes systematic laboratory instruction in the setting up and care of the various forms of fluid, thermo and secondary batteries, in the use of galvanometers, resistance coils, condensers, etc.; in the measurement of resistance of conductors and batteries, insulation of cables, electro-motive force, etc.; in the construction and testing of electro-magnets, and in the applications of electricity to industrial purposes.

Special attention is given to the magnitude of electrical units and their relation to the mechanical units. Instruments of the latest and best forms are provided for this work.

During the year the junior and senior students make visits of inspection, in charge of an instructor, to the prominent manufacturing establishments of Chicago, Indianapolis, and other cities. Such trips are of very great value to the students, affording them an opportunity of seeing in actual practice those processes of manufacture whose theory they have already studied in the class room.

Graduating Theses.—As a condition of graduation, students in the school of mechanical engineering are required to present a thesis on some approved subject. Such theses must be original compositions of suitable length on some subject of interest to the mechanical engineer. The subjects are so selected as to necessitate original work, either of investigation or of experiment, on the part of the student. The originals of these are preserved in the university library.

The following are subjects of those presented by graduating classes:

1. "Bessemer Steel: Its History and Practical Manufacture."
2. "Steam Engine indicators: the Various Forms in Use and their Applications."
3. "Methods of Testing Steam Boilers, including the Result of an Experimental Determination of the Efficiency of a Pair of Steam Boilers."
4. "The Stones and Quarries of Indiana, including Experimental Determination of their Physical Properties."
5. "Windmills: Their History and Present Forms, including Experiments in Determining their Efficiency."
6. "Thermo Chemical Batteries."
7. "Electro-Plating with Aluminum."

8. "Determination of Efficiency of Dynamos and Motors."
9. "Cable Railways."

MECHANICAL LABORATORY.

The Mechanical Laboratory is wholly occupied by the School of Mechanical Engineering.

The main portion of the building is occupied by two recitation rooms, a drawing room, a testing laboratory and an office. The drawing rooms are furnished with tables, drawing boards and T square for each student. There is also provided, for general use, a supply of the more expensive drawing instruments, such as proportional dividers, protractors, beam compasses, etc., and a large number of rubber curves.

In the wings of the building are a wood-working room, a foundry, a forge room and a machine room; and connected with these, an engine room, a tool room and a coat room. The wood-working room contains twenty benches, with full sets of bench tools for wood, eleven lathes for turning, a grindstone, a circular saw and a scroll saw. The foundry is equipped with a cupola furnace for iron, a crucible furnace for brass, a core oven, and a full supply of sand, flasks and molders' tools. The forge room contains fourteen forges, to which air blast is supplied by power, fourteen anvils and fourteen sets of the usual smithing tools. The machine room contains two screw-cutting machine lathes of sixteen inch swing, four of fourteen inch swing, and one of ten inch swing; also a machine planer, a sharper, a universal milling machine, a grindstone, two vertical drilling machines, a speed lathe, and an emery grinder. These machines are provided with all the necessary small tools, cutters, etc., necessary to their complete and economic action. In the machine room are benches, fitted with vises for use in connection with hand-work in metal.

The motive power for the shops is supplied with an automatic cut-off engine of thirty-five horse power.

TESTING LABORATORY.

The work done by the laboratory includes the determination of the strength and other physical properties of the materials of construction, the testing of steam boilers by hydraulic pressure, examination and correction of steam gauges, determination of the evaporative power and economy of combustion of fuel of steam boilers, and of the efficiency and amount of fuel consumed per horse power of steam engines. The laboratory also determines the relative value of coals for steaming purposes, conducts competitive tests of rival engines, boilers or other machinery, and is prepared to make experimental determinations in other matters of interest to the engineering profession.

Students perform work in the testing laboratory as part of the regular course in strength of materials, boilers and steam engines, and assist in all commercial and experimental work done by the laboratory.

Among the recent additions to the experimental machinery is a 10 H. P. improved balance dynamometer. With this instrument reliable experimental work may be done in all tests of engine friction, and of the power transmitted by machinery.

The laboratory is provided with a powerful machine for testing the strength and elasticity of materials. The machine can exert any strain up to 50,000 pounds, and can subject the specimen to tension, compression or transverse strain. In addition, the laboratory possesses a steam gauge tester, steam engine indicator, planimeter, micrometer and other necessary appliances, and has the use of the thoroughly equipped shops of the university.

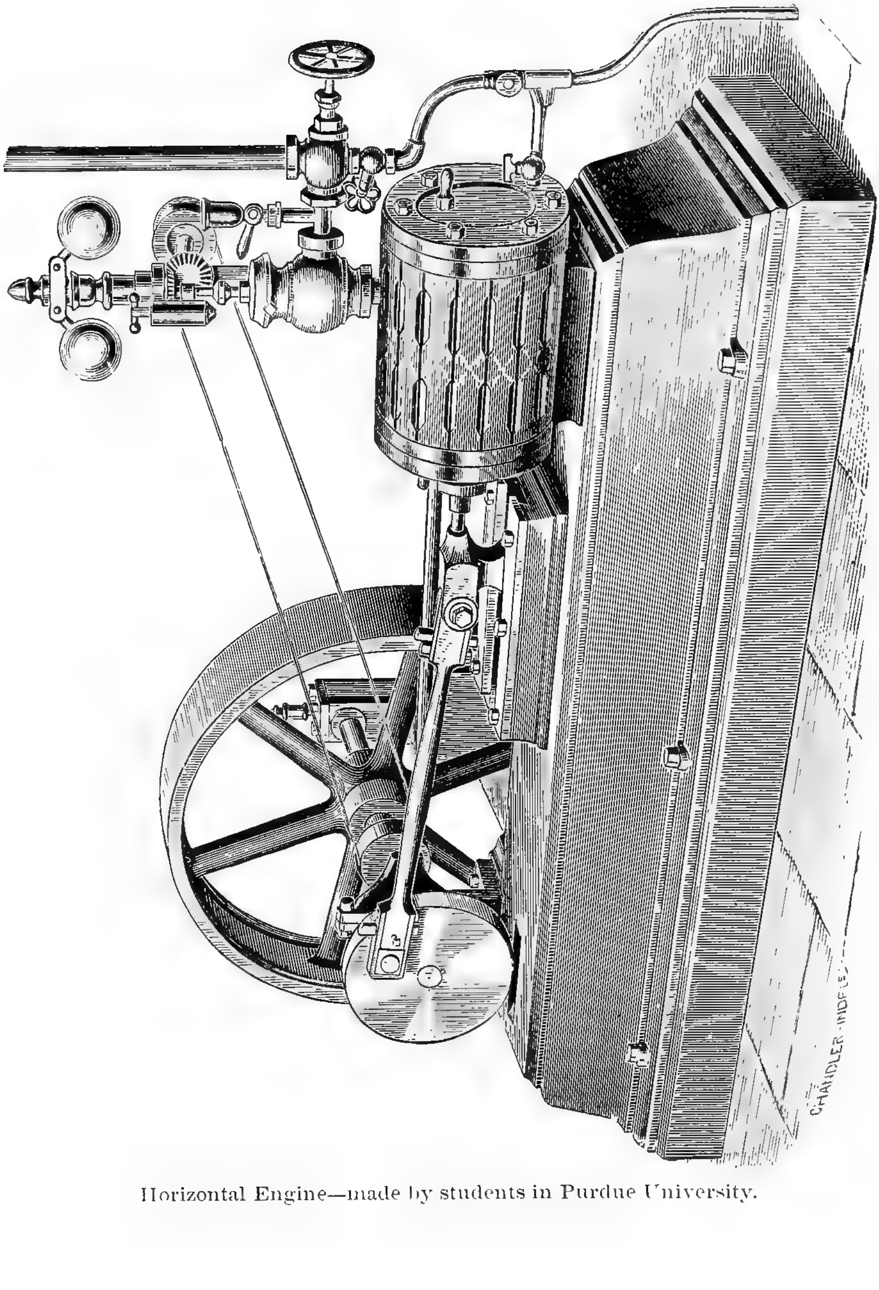
Speaking of the work in the School of Mechanics and Engineering, Prof. Goss says:

"Our shop work is intended chiefly as a preparation for advanced work in engineering and has been conducted on the same general plan, which at present governs it, ever since it was started, ten years ago. Its steady growth has been uninterrupted. We now have 125 students working every day.

NOTE.

The accompanying plates represent work done by students in the university. The sideboard is made of wild cherry, and the smaller articles of walnut, poplar or pine. The carving was done as a daily class exercise in the regular course of instruction, and chiefly by young ladies.

Specimens of wood carving made by students (mostly by lady students), in Purdue University.



Horizontal Engine—made by students in Purdue University.

3. Rose Polytechnic Institutute.

The institute was founded in 1874, by the late Chauncey Rose, of Terre Haute, and was opened March 7, 1883.

It is devoted to the higher education of young men in engineering, including in this term all those productive and constructive arts by which the forces of nature are made subservient to the needs of man, and the principles which underlie those arts.

Its course of instruction includes, therefore, the principles and the practice of engineering with special reference to the following branches of the subject: Mechanical engineering, civil engineering, chemistry, physics, electricity and drawing.

"Those who are actively engaged in the practice of engineering are generally agreed that every young man who is in training for an engineer should acquire familiarity with the practical side of his profession—especially that mechanical engineers should understand the use of tools and machinery. The acquirement of this manual dexterity may precede, accompany or follow the training in engineering principles. In this school it accompanies it.

If the student's study of principles is supplemented by weekly practice in a shop where these principles are seen applied, his entrance upon the life of an engineer will be an expansion of his course of study, rather than an abrupt transition to a new mode of life.

The important fact which underlies any sound scheme for school shops is that machinery is to have a constanly increasing share in the conversion of matter into useful form. The educated mechanic must understand the practical limits of mechanical production and all the possible ways in which those limits can be extended. He must know by practice how to design, construct and assemble the parts of a machine, as well as how to finish its product by skilful handicraft, and he should also know how to make his tools. The power of an engineer to decide, upon general grounds, the best form and material for a machine, and to calculate its parts, is vastly increased by blending with it the skill of the craftsman in manipulating the material.

The work of the students in mechanical engineering is so distributed that they spend sixteen hours per week in the shop during the first year and ten hours a week during the rest of the course. During this time they receive instruction from skilled workmen in the various departments, by whom their practice is constantly supervised.

Each student receives instruction tri-weekly in drawing; by this discipline such perception of form and proportion is secured by the students that, when they undertake shop work, they make more rapid and satisfactory progress than those who have not had the advantage of this training. And each student, as soon and as far as possible, is required to make working-drawings of every article that he produces, for the ability to make and to read drawings is an important characteristic of an engineer.

As the workshop is educational in its character, and is managed solely for the advantage of the students, each one can advance as fast as possible, unchecked by the dificulties of his neighbors or the financial necessities of the institution.

To these considerations in favor of a school shop must be added another which outweighs them all; that students come to their shop work with their perceptive facilties, the reason, the judgment and the taste, all under constant and careful training in other departments of the school, and also that their interest in the study of theoretical principles is greatly enhanced by the opportunity offered for their immediate application to various problems arising out of their shop work.

In accordance with these general ideas the *Rose Polytechnic Institution* offers to young men a good education based on mathematics, living languages, physical sciences and drawing, together with a practical training in and a familiarity with some form of applied science."

ADMISSION.

Candidates for admission to the freshman class must be at least sixteen years old, present certificates of good standing and pass examnation in the following branches, viz: English grammar, history of the United States, geography, arithmetic and algebra to quadratic equations, including radical quantities.

Advanced standing.—Candidates for admission to advanced standing must show that they are qualified to enter the class which they desire to join, either by furnishing satisfactory certificates of work done at other institutions, or by examination.

Graduates of the manual training schools, which are now to be found in nearly all large cities, will generally be able to enter at the beginning of the sophomore year.

Graduates of institutions of recognized standing are admitted as post-graduate students and may select studies and exercises as they desire.

The diplomas of high schools or academies of good character may be received in lieu of an examination for an admission to the freshman class. When admission is sought in this way, the diploma is to be accompanied by a copy of the course of study of the school, certified to by the principal.

The number of students admitted to the freshman class is limited to fifty. It is not intended to admit a greater number than will be compatible with the best possible use of the facilities of the institute. Should the number of applicants for admission exceed fifty, those admitted are selected in the order of their application or notification of intention, all other things being equal.

FEES.

No charge for tuition is made to *bona fide* residents of Vigo county, Indiana. All others pay seventy-five dollars each per year. Every student, of whatever place of residence, pays an annual fee of twenty-five dollars for use of chemicals, breakage and contingencies.

The entire expense for tuition, board and materials need not exceed say three hundred dollars per year. Economical arrangements can be made by which this amount is considerably reduced.

COURSE OF STUDY.

The course of study occupies four years of three terms each. There are four classes, freshman, sophomore, junior and senior.

The classes are instructed by recitations lectures and laboratory and shop practice, which together constitute a symmetrical course of study.

Many subjects, such as mathematics, language, physics, theoretical mechanics, etc., are common to the courses in mechanical and civil engineering. In such subjects the recitations and lectures are attended by students in both courses; their exercises during "practice" hours, however, are widely different.

Courses of lectures are given by the president, professors and others in geology, astronomy and other topics not included in the regular course of study. Instruction in physics and chemistry is given largely by means of laboratory practice. Students are in all cases required to take notes and to sustain examination on the lectures.

Each class holds a *Journal Review* meeting once a month, for which members of the class prepare brief summaries of the contents of the current numbers of the leading scientific and technical journals of the world. The meeting is in charge of some member of the faculty who directs the discussions.

Practice and laboratory work is offered in—

1. Mechanical engineering.
2. Civil engineering.
3. Chemistry.
4. Physics, including the application of electricity.
5. Drawing.

Members of the freshman class practice alternately in the wood shop and the machine shop. At the beginning of the third term of the freshman year the election of courses is made, after which those electing civil engineering or chemistry devote their practice hours to these subjects.

In practice and laboratory work the class system is not adopted. Each student, working independently of others, advances as rapidly as possible. A certain standard of excellence, however, must be reached by all.

At the close of the year each member of the senior class presents

to the faculty a paper, in which he records the independent investigation of some subject congenial to his tastes, and included in the scope of his course. These theses, with all the drawings which accompany or illustrate them, are preserved in the library of the institute.

Courses.—Provision is made for three separate courses, the election being made at the beginning of the third term of the Freshman year. They are:

1. Mechanical engineering.
2. Civil engineering.
3. Chemistry.

A special course in electricity and its applications is arranged in connection with the course in mechanical engineering. It is believed that those who wish to fit themselves for the intelligent manufacture of electrical apparatus and machinery and for designing the same, or for the installation and management of electric light and power stations, for expert work in connection with telegraph and telephone service, etc., will especially need the greater part of the training which the course in mechanical engineering affords. The course in electricity is therefore built upon this; the election is made at the beginning of the sophomore year and a part of the practice time is devoted to electricity from that time until the end of the course, in addition to the physics and laboratory practice of the junior and senior years, during which a large share of the time of the students is devoted to the subject.

The outline of the course of study, giving the distribution of time as shown below, applies to all of the courses on the assumption, already noted, that students in civil engineering and in chemistry devote the hours put down to "practice" to these subjects, either in field-work, laboratory, lecture or recitation, to which, also, they give the hours in the senior year set down for machine design and electricity. Special students in electricity devote two of the practice hours to that subject from the beginning of the Sophomore year.

The course in mechanical engineering, in detail, is as follows:

	FIRST TERM.	SECOND TERM.	THIRD TERM.
Freshman Year.	Algebra; Geometry; Free-hand drawing; Elementary Mechanics; Elementary Physics; Languages; Practice in Machine shop —Section A; Practice in Woodshop—Section B.	Algebra; Geometry; Mechanical Drawing; Elementary Mechanics; Elementary Chemistry; Language; Practice in Machine shop, —Section B; Practice in Woodshop—Section A.	Algebra; Geometry; Trigonometry; Free-hand drawing; Elementary Mechanics; Elementary Chemistry; Language; Foundry and Blacksmith shop and Practice in Woodshop one-half term each, Sections A and B.

	FIRST YEAR.	SECOND YEAR.	THIRD YEAR.
Sophomore Year.	Spherical Trigonometry; Analytic Geometry; Descriptive Geometry; Free-hand and Mechanical Drawing; Chemistry and Chemical Laboratory; German; Practice in Machine Shop, Toolmaking, Foundry work, care of Boilers and Engines.	Analytic Geometry; Descriptive Geometry; Free-hand and Mechanical Drawing; Chemistry and Chemical Laboratory; Mineralogy; German; Practice in Machine Shop, Toolmaking, Foundry Work, care of Boilers and Engines.	Analytic Geometry; Introduction to Differential and Integral Calculus; Introduction to the Theory of Determinants; Free-hand and Mechanical Drawing; Chemistry and Chemical Laboratory; Mineralogy; Lectures on Astronomy; German; Practice in Machine shop, Tool-making, Foundry work, care of Boilers and Engines.
Junior Year.	Differential Calculus; Mechanical Drawing; Analytical Mechanics; German Translations; Practice in Machine Shop, making Standard Tools, Forging, Tempering, etc.	Differential Calculus; Integral Calculus; Mechanical Drawing; Physics; Lectures on the method of Least Squares; Scientific German, Periodicals, etc.; Practice in Machine shop, making Standard Tools, Forging, Tempering, etc.	Integral Calculus; Mechanical Drawing; Physics; Lectures on the method of Least Squares; French; Practice in Machine shop, making Standard Tools, Forging, Tempering, etc.
Senior Year.	Applied Mechanics; Thermo-dynamics; Chemical Technology; French—reading and translation; Physical Laboratory; Machine Design; Engineering Laboratory; Practice in Woodshop—construction of Patterns for foundry use from working drawings of machines designed by members of the class.	Applied Mechanics; Thermo-dynamics; Chemical Technology; Study of English Classics; Physical Laboratory; Machine Design; Engineering Laboratory; Practices in Woodshop—construction of Patterns for foundry use from working drawings of machines designed by members of the class Thesis work.	Applied Mechanics; Thermo-dynamics; Chemical Technology; Lectures on Geology; English Classics, Constitution of the United States; Physical Laboratory; Machine Design; Engineering Laboratory; Practice in Woodshop—construction of Patterns for foundry use from working drawings of machines designed by members of the class. Thesis work.

Mechanics.

This subject, forming as it does, the most important element in the course in mechanical engineering, is considered both as to principles and practice. Instruction is given by means of recitations, lectures, laboratory and shop practice. It is thus attempted to combine in the best proportions both theory and practice, and experience has proved that each acts as a stimulus to the student in his pursuit of the other.

The study of the principles of mechanics begins with the first term

of the freshman year and continues throughout that year. A text book is used and the work consists mainly of a study of the fundamental principles of matter and energy, with applications to real problems which may present themselves in the work-shop practice.

It is again taken up in the junior year and five lessons a week in analytical mechanics are given during the first term; the instructions being by text-book, recitations and lectures.

Throughout the senior year four lessons a week are given, the text-book used being Rankine's Applied Mechanics. In this year, also, instruction is given in machine design, in steam engineering, and a large part of the time of the student is given to experimental work in the laboratory. A more detailed exhibit of this instruction is given in the schedule below.

The laboratory practice of the senior year includes the use of testing machines in the determination of the strength of materials, of various forms of dynamometers, the steam engine indicator, tests of boilers, engines, pumping stations, electric light installations, etc., together with numerous experimental studies of the principles of mechanics.

Course in Mechanics.

	FIRST TERM.	SECOND TERM.	THIRD TERM.
Freshman Year.	Elementary mechanics; Laws of motion. Equilibrium of forces, friction, law of work applied to simple machines; two lessons a week. Practice in machine shop; filing, turning, screw threads, balls, planing, boring, finishing scraping to true surface, polishing, etc.; Lectures on the care and use of tools and on the construction of machines; eight hours a week. Practice in woodshop; use of hand tools, chisels, saws, planes, bits, etc.; laying out frames from working drawings; use of the turning lathe, circular saws, jig-saw, planing and boring machines, with lectures on tools, etc.; eight hours a week.	Elementary Mechanics; transmission of power, dynamometers, kinetic and potential energy, moment of inertia, effects of stress on simple structures; two lessons a week. Practice in machine shop and woodshop of first term continued.	Periodic motion, harmonic motion, springs pendulum, etc.; two lessons a week. Practice in machine shop continued; forging, foundry work, and care of boilers; eight hours a week. Practice in woodshop continued; construction of patterns of a simple character; eight hours a week.

Course in Mechanics—CONTINUED.

	FIRST YEAR.	SECOND YEAR.	THIRD YEAR.
Sophomore Year.	Practice in machine shop; construction of useful machines from working drawings, such as foot lathes, drill presses, power lathes, pulleys, hangers, etc.; forging tools for use in machine shop, care of boilers and engines, practice in brass foundry and molding room; ten hours a week.	Practice in machine shop of first term continued; ten hours a week.	Practice in machine shop of first term continued; ten hours a week.
Junior Year.	Analytical mechanics, equations of motion, attraction, potential hydro-dynamics; five lessons a week. Practice in machine shop; construction of large machine lathes, power presses, steam engines, etc.; making standard tools such as reamers, drills, gauges, etc., including the forging and tempering of the same; ten hours a week.	Practice in machine shop of first term continued; ten hours a week.	Practice in machine shop of first term continued; ten hours a week.
Senior Year.	Rankine's Applied Mechanics; forces in straight line, parallel and inclined forces, stress, ellipse of stress, four lessons a week. Machine design; linkwork, gears, cams and simple movements, design of simple machine; six hours a week. Laboratory work; six hours a week. Practice in wood shop; construction of patterns for foundry use from working drawings, of machines designed by members of the class; eight hours a week.	Applied mechanics continued; frames, strength of materials, practical application to joints, pipes, boilers, beams, etc.; four lessons a week. Machine design continued; study of cost of machine construction, design of automatic machinery; six hours a week. Laboratory work; six hours a week. Practice in woodshop; construction of patterns for foundry use from working drawings of machines designed by members of the class; eight hours a week.	Applied mechanics continued; dynamics of rigid bodies with applications to mechanism. Machine design continued; finishing the detailed drawing with blue-prints of a machine the design of which has been wholly the work of the students; six hours a week. Laboratory work; six hours a week. Practice in woodshop; construction of Patterns for foundry use from working drawings of machines designed by members of the class; eight hours a week.

Engineering Laboratory.—For the investigation and solution of engineering problems a collection of the best apparatus and appliances is in process of formation. The following are now at hand; the list will be increased during the next year.

The Forty-horse Power Brown Engine, which is equipped with variable cut-off, independent slide-valves and complete arrangements for taking indicator cards under widely varying conditions.

Two Steam Engine Indicators.

An Absorption Dynamometer, which is arranged so as to be capable of instant application to the pulley on the main shaft of the engine, capable of absorbing thirty-horse power.

A Bracket Cradle Dynamometer, especially designed for the study of dynamos, electric motors, etc.

A Transmission Dynamometer, capable of transmitting ten-horse power, arranged so as to be easily used with machine tools, dynamo-electric machines or other power consumers.

A Testing Machine of 100,000 pounds capacity, by means of which tensile strength, elasticity, resistance to compression, deflection under traverse stress, etc., etc., can be ascertained for all materials used in engineering processes.

A smaller Testing Machine, for the testing of cements, etc , where less force is required.

An Accurate Linear Dividing Engine.

A Comparator, for comparison of standards of length.

Standard Bars, representing the foot and the meter.

A Strong and Senitive Balance, with standard heavy weights.

Thermometers, which have been carefully calibrated and whose errors have been ascertained by comparison with standards.

Speed Counters and Speed Indicators.

An Electric Chronograph, for studying variation of speed in a single revolution.

Micrometer and Standard Gauges.

To which may be added many instruments of precision in the physical laboratory, which are available whenever required for the study of engineering problems.

The engineering laboratory is intended to serve the purpose of both the civil and mechanical engineering departments.

Practice.

"The workshops and auxiliary rooms are a complete manufacturing establishment where various sorts of work in iron and wood are seen at every stage of progress in the hands of the students. The scheme of practice in operation comprehends more than the cultivation of mere skill in handicraft; it includes the development of constructive power. In the earlier stages of his work the student acquires facility in the use of tools and machinery in the making of some of the simpler elements of a machine, or the parts of a useful product. At a later period these parts are assembled and the machine is completed, being subjected to severe tests as to the harmony and adaptation of its various parts. In this process the standard of excellence is never lower than that of the best manufacturing establishments. The commercial value of these products is kept out of sight in planning the practice of the student, whatever is best adapted to the successful development of skill being utilized. But constructive power is of a higher order than that of skill in handicraft and is of relatively greater value to the mechanical engineer. For this reason it is believed to be important to cultivate this power by shaping the practice work of each student so that it shall lead, before the course is finished, to the completion of a variety of mechanical products, which shall have of themselves a real commercial value."

The practice of the freshmen, sixteen hours per week, is one half given to the workshop and the other half to the machine shop, forging

and foundry work. It is accompanied by weekly lectures on the care and use of tools and on the construction and management of machines.

The practice of the juniors and sophomores, ten hours a week, is in the tool-room, blacksmith shop, engine room and machine shop.*

That of the seniors, eight hours per week, is in the wood shop, in the construction of patterns for foundry use from working drawings of machines. The drawings are of machines designed by members of the class from original data, worked out during their study of machine design.

The Wood Shop.—Students in this room learn to lay out work with knife and pencil; the use of planes, saws, chisels and other wood working hand tools; wood-turning, machine sawing, planing and boring. the use of shaping and moulding machines and the auxiliary manipu; lations of all the machinery used; making, as they acquire sufficient knowledge, a large variety of cabinet work and all the foundry patterns required by the machine shop, the latter being made wholly from working drawings.

The Tool Room.—All hand tools being the property of the institute, are classified and stored in this room; and every person who uses one is made responsible, by a system of checks, for its safe return.

The Forge Room.—Students in this room acquire a practical knowledge of forging, drawing and tempering of steel sufficiently extensive to form and temper all the tools which they are likely to use.

The Engine and Boiler Rooms.—All students in these rooms learn the management of the engine and boilers under test conditions, and will have an opportunity to experiment with different kinds of fuel; they take indicator cards from the engine under different loads and positions of the valves, and from these cards they are instructed in regard to the best positions of the valves for the performance of any specific work.

The Machine Shop.—The freshman class begin here with the rudiments of iron work, such as chipping, filing, scraping to a true surface, turning, boring, drilling, tapping, reaming, etc., and as soon as they have attained sufficient dexterity are put at work upon the construction of an 8″ swing, 3′ bed lathe, or some machine requiring a similar class of work.

The sophomore class have under course of construction a number of speed lathes and drill press, and a 10″ turret lathe. Students of the sophomore and junior classes are required to spend a part of their practice time each term in the boiler room, tool room and foundry.

The junior class make the taps, reamers, miling cutters, etc., used in the shop, and are also constructing a 16″x6′ bed turret lathe. All students are required to work to standard gauges and from working drawings. During practice hours all students are under the immediate supervision of skilled workmen.

*In the equipment of these rooms more than $40,000 has been expended.

Each member of the senior class in the department of mechanical engineering designs one or more machines during the year, and furnishes complete working drawings of the same. These drawings are then used by the freshmen from which to make their patterns, and by the other classes in making the machines.

An excursion is made each year by the members of the senior class to one of the large manufacturing cities of the country. The class is accompanied by one of the members of the faculty and a special study is made of the most recent machinery and methods.

Apparatus.—The polytechnic shops are furnished with the best modern tools and machinery for working wood and iron. The equipment of the wood shops consists of thirty-six benches, twenty-five "kits" of carpenters' tools, seven wood-turning lathes, three circular saws, two jig saws, one band saw, one double spindle molding machine, one panel planer, one Gray & Woods' planer, one automatic knife grinder, one horizontal boring machine.

The equipment of the machine shop consists of the following tools: Sellers planer 23″x25″x8′, Pond lathe, screw-cutting, 26″x20′, same 22″x10′, Powell lathe 19″x10′, Washburn lathe 16″x8″, Flather lathe 16″x8′, Lodge & Barker lathe 18″x10′, Pratt & Whitney lathe 21″x18′, Fitchburg lathe 15″x6½′, Putnam lathe 15″x6′, Pratt & Whitney lathe 16″x8′, Ames lathe 16″x7′ and one 16″ swing, 6′ bed turret lathe made in the shop, seven chucks, universal and independent, one polishing lathe, three speed lathes, one Brainard milling machine with spiral and gear-cutting attachment, Hendcy 24″ shaping machine, Bett's 40″ radial drill, Pond 32″ upright drill, emery wheels, buff wheels, grindstones, drills, reamers. standard gauges, chucking reamers, squares, surface plates, and a full equipment of smaller tools.

The Forge Room.—Is equipped with two substantially built forges each furnished with power blast. There are also two complete sets of swages. and other tools for doing all kinds of blacksmithing.

The Brass Foundry.—A brass foundry has recently been completed and is now in running order. Students in the foundry practice in brass moulding from a large variety of patterns and under the immediate supervision of a skilled molder.

The engine and boiler rooms contain a 40-horse power Brown engine and five boilers; the engine serves the double purpose of a motor and a piece of apparatus; it has a variable cut-off with four independent slide-valves, and represents the best American workmanship. There is also a Crosby test gauge; a Murdock No. 20 exhaust injector, and a Hancock No. 12½ inspirator, with a sectional model of the same.

The boilers are connected so as to be used in every possible combination; arrangements have been made to weigh the coal and ash, and to measure the water used, and these rooms become available for studying problems in steam engineering by actual experiment.

Drawing.

The freshman class spend the first and third terms in model drawing and shading with lead pencil and crayon; the second term in geometrical drawing, including the making of simple working drawings. The sophomore class spend two hours a week in sepia and pen drawings, and four hours a week in the use of drawing instruments and in the theory and practice of orthographic, isometric and perspective projections and shades and shadows.

The junior class spend six hours a week in the construction of gear tooth and cam outlines and use of the odontograph, the principles of stereotomy, special problems in machine movements and in making finished and working drawings from specific data.

All drawing is done under the eye of the instructor.

The course as arranged by years and terms, is shown below.

Apparatus.—The free-hand drawing room is elegantly finished, and provided with examples of the most approved methods of drawing. It contains perspective models, made at the Royal Sculpture Gallery, at Dresden; a collection of casts of antique forms made by Malpieri, of Rome; and a full set of the models designed by Walter Smith, of Boston.

The mechanical-drawing room is equally commodious, and easily supplied from the shop with the examples of machine construction. In this room the students see specimens of the drawing and machine-work done at other polytechnic schools, especially the large collection presented to this institution by the Imperial Institute of Technology, at St. Petersburg.

The following schedule shows the course in drawing, in detail:

COURSE IN DRAWING.

	FIRST TERM.	SECOND TERM.	THIRD TERM.
Freshman.	Free-hand — Six hours per week. Outline Drawing from Models.	Mechanical—Six hours per week. Geometrical Drawings and simple Working Drawings.	Free-hand — Six hours per week. Shading from models with pencil and crayon, Machine Sketching.
Sophomore.	Free-hand — Two hours per week. Sepia Drawing from Models. Mechanical—Four hours per week. Line and Brush Shading, Section coloring.	Free-hand—Two hours per week. Pen and Ink Drawing from Models. Mechanical—Four hours per week. Shades and Shadows, Isometric Projections.	Free-hand — Two hours per week. Pen and Ink Drawings for Photo-Engravings. Mechanical—Four hours per week. Perspective working Drawings, Tracing and Blue Printing.
Junior.	Mechanical—Six hours per week. Problems in Stereotomy, Cam Outlines.	Mechanical —Six hours per week. Gear Tooth Outlines and use of Odontograph, Special problems in Machine Movements.	Mechanical — Six hours per week. Making Working and Finished Drawings.

VIII. IOWA.

The Agricultural College.

The Iowa State Agricultural College is one of the colleges which receives the benefit of the National Land Grant Act of 1862. Tuition is free to all Iowa students.

Six courses of study are offered at the college, all scientific, technical or industrial, according to the clear intent and in the full spirit of the organic laws of Congress that founded the college. They are, in brief :

1. In industrial science.
2. For ladies in science, literature and domestic economy.
3. In agriculture and horticultural.
4. In mechanical engineering.
5. In civil engineering.
6. In veterinary science.

The requirements for admission are placed quite low so that the common schools of the State may furnish the necessary preparation or nearly so. The requirements for admission to the freshman class are, evidence of a thorough knowledge of orthography, English grammar, arithmetic, geography, United States history, human physiology and (except in the veterinary course), algebra through simple equations.

The department of mechanical engineering is equipped with five shop rooms, besides tool and engine and supply rooms, drafting rooms, recitation rooms, blue-print room, etc.

This department aims to graduate mechanical engineers, not mere machinists. The young men are fitted not only to superintend the manufacture of machinery, but to design it.

The students have work or shop exercises, involving many principles of construction which succeed each other in systematic order through the course. In this way they are able to learn, in the time devoted to the shop, the most that is possible about machine tools, how to use them and the variety of work they are intended to do. Occasionally a job of repairing, or constructing a piece for actual use is given to the best students, when well suited to replace one or more of the regular shop exercises. Thus, without loss of time, they experience some of the benefits of performing actual work. All shop work is made from mechanical drawing. Practice in vise work and a course in forging is taught. In the wood-shop which is well supplied with wood-working machinery, work benches and carpenter's tools, a carefully systematized course comprises instruction in carpentry, wood

turning, the running and care of circular, band and jig saws, planers and molding machinery—the student actually using each machine. Later comes a thorough course in patternmaking. This is preceded by careful instruction in molding, where also are studied the reasons for the forms and various parts of patterns as a preparation for their construction.

In the mechanical laboratory the older students go through with the regular commercial testing of boilers, engines, pumps, etc. They accurately measure the weight of steam a boiler gives for each pound of fuel burned, testing its quality, wet or dry steam, the number of pounds of steam required by the engine for each horse power it develops, the quantity and potential of electric current obtained from a dynamo for each horse power used, and again the power furnished by an electric motor, compared with the current supplying it. The efficiency of steam pumps and injectors, and of all machinery consuming power is studied in this way, thus supplementing in a most thorough manner the engineering instruction of the class room. An Olsen testing machine is used for determining the tensile strength, elasticity and resistance to crushing, of the materials of engineering, wood, iron and steel, the strength of boiler plate and of riveted joints, also the strength and stiffness of beams used in buildings and bridges. Brick, stone and cement are likewise tested and every possible means is adopted to teach the underlying principles of engineering, and to illustrate them thoroughly by actual trial and work done by the students themselves.

It is the policy of the mechanical department to give its students a training so practical and thorough, both in shop work and drawing, that it shall enable them as machinists and draughtsmen to earn a living, to get a foothold, immediately on graduating from college. At the same time the course of study and practice is sufficiently comprehensive and liberal to give graduates a strong impetus toward the higher positions in their profession.

The following extract from the report of the professor in charge of this department for 1886–1887 shows some of the results of the work :

"A radical change has been made in the method of giving instruction in shop work—the change being from what is known as the Russian or exercise system which does not produce anything useful to the manufacturing system, all of the products of which are to be used in the shops or sold in the market. This change has resulted in a marked improvement both in the interest of and progress made by the students. In fact, quite a number of students have asked for extra shop work. The last freshman class voted unanimously to have shop work on Saturday in order that they might have a full, uninterrupted day. When a whole class of students will voluntarily forego the weekly holiday with its accompaniments of base ball, fishing, etc.,

and work in the shops instead, it shows that they get something which they need and appreciate.

During the past two years the students have made in the carpenter shop ten carpenters' benches, with tool cases complete, forty desk schools for the mechanical drawing rooms, eighteen small instrument cases, over seven thousand cleats for the Edison Electric Light Company, thirty wood screw clamps, two hundred and twenty turned cedar posts, one black walnut office desk, one oak washstand, one oak dressing case, and have done about one half the work on a fine wardrobe bed. In addition to the above a large variety of work which cannot be listed here has been done for the college.

In the machine shop the students have made ten carpenters' and machinists' vises, together with various tools and pieces of apparatus for the department, one adjustable speaker's stand, and two improved letter presses of original design; also, a small steam engine, which had been set aside as useless, has been worked over into a model for illustrating the action of valve gears and thus made of value in the study of the steam engine. When contemplated attachments are added to this model, it will be worth at least $300 to the department.

IX. MAINE.

The Maine State State College of Agriculture and the Mechanical Arts.

This institution is one of those established in accordance with the act of Congress of 1862.

The purpose of the college, as stated in the annual report for 1888, is "to give at a moderate cost, the advantages of a thorough, liberal and practical education. It seeks to do this by means of approved methods of instruction, and especially by making prominent the system of practically applying in the drawing room, in the laboratory, in the shop and in the field, the lessons of the class-room. It thus endeavors to make its courses of high practical value."

While the courses of study fully meet the requisition of the act of Congress, and are especially adapted to prepare the students for agriculture and mechanical pursuits, it is designed that they shall be also sufficiently comprehensive, and of such a character as to secure the discipline of mind and practical experience necessary for entering upon other callings or professions.

ADMISSION.

Candidates for admission to the freshman class must not be less than fifteen years of age, and must pass a satisfactory examination in arithmetic, geography, English grammar (especial attention should be given to orthography, punctuation and capitals), history of the United States, physical geography, book-keeping, algebra to logarithms and plane geometry.

Candidates for advanced standing must sustain a satisfactory examination in the preparatory branches, and all in the studies previously pursued by the class they propose to enter.

Tuition is thirty dollars a year, divided equally between the two terms. The cost of material and repair of tools for the course of instruction in the vise shop is ten dollars; in the forge shop, nine dollars; in the wood shop, four dollars.

COURSES.

Five full courses of instruction are provided, viz: A course in agriculture, in civil engineering, in mechanical engineering, in chemistry, and in science and literature.

The studies of the several courses are essentially commom for the first year, and are valuable not only in themselves, but also as furnishing a necessary basis for more technical studies and the practical instruction of the succeeding years:

The course in mechanichal engineering, in detail is as follows:

FIRST YEAR.

FIRST TERM.	SECOND TERM.
Solid Geometry.	Lorgarithms and Trigonometry.
Physiology.	Botany.
Rhetoric.	French.
Free-Hand Drawing.	Mechanical Drawing (F. of T.).
Dissecting.	Botanical Laboratory Work (L. of T.).
P. M. Labor on Farm.	P. M. Labor on Farm.

SECOND YEAR.

FIRST TERM.	SECOND TERM.
Descriptive Geometry.	Analytical Geometry.
French.	Drawing and Kinematics.
Physics.	Physics.
General Chemistry.	Surveying.
P. M. Carpentry.	Qualitative Chemistry.
Laboratory. Work in Chemistry.	P. M. Mechanical Drawing and Forge Work.

THIRD YEAR.

FIRST TERM.	SECOND TERM.
Calculus.	Calculus (F. of T.).
Kinematics.	Descriptive Astronomy (L. of T.).
Vise Work.	Mechanics and Machine Design.
P. M. Machine Drawing.	Logic.
	Elements of Mechanism.
	Link and Valve Motions.
	P. M. Isometric and Cabinet Projection and Machine Drawing.

FOURTH YEAR.

FIRST TERM.	SECOND TERM.
Steam Engineering.	Steam Engineering.
Practical Astronomy.	Wood Turning.
Political Economy.	Hydraulic Engineering.
P. M. Machine Drawing and Designing.	Mineralogy and Geology.
	U. S. Constitution.
	P. M. Machine Drawing, Designing and Thesis Work.

It is the design of this course to give such a knowledge of mathematics, mechanics, principles of mechanism, drawing and manual art, as shall enable the student successfully to enter practical life as an engineer with the same through education in subjects required to fit him for general duties of life as is afforded by the other courses.

The first two years' work is identical what that of the students in civil engineering, except that carpentry and forge work are taken the second year in place of part of the drawing. In the junior year, the first term is devoted to the geometry of machinery, showing the students how different motions may be obtained independently of the power required. Special attention is here given to the subject of gear-

ing, and a full set of problems worked out, illustrating cases commonly occurring in practice. In the second term of this year the subject of the geometry of machinery is continued by lectures on other methods of transmitting motion, as by belts, cams, couplings and links. Considerable time is given to the study and designing of the various valve and link motions used on the steam engine. During the same term instruction is given in mechanics and the laws of the strength of materials, the student being required to design machine details in accordance with those laws.

The first part of the first term, senior year, is employed in studying the laws of the expansion of steam, and their influence upon the construction of steam engines and boilers, the subject being illustrated by experiments on the shop engine, with the aid of an indicator. During the remainder of the term the students are engaged in designing engines and other machines, and in making detailed drawings of the same, such as would be required to work from in the shop.

During the last term, senior year, the study of steam engineering is continued in its application to compound engines, and the subject of hydraulic engineering is taken up briefly by lectures on the storage of water for power and the theory and construction of modern water wheels.

SHOP WORK.

There are now three shops equipped according to the Russian system, and work in these is required of all students in the course. The first term of the sophomore year, two hours of each day are devoted to work in carpentry, special attention being given to accuracy of workmanship.

During the second term of the same year, the student receives instruction in forge work, including the welding and tempering of steel. A course in vise work during the first term of the junior year gives the student practice in the various methods of shaping and fitting metals by the use of the chisel, hack saw and file. During their second term, the junior students in this course take turns in running the shop engine, and are taught the rules of safety and economy in this branch of engineering. Instruction in wood-turning is given during the last term of the senior year.

DRAWING.

The work in drawing commences with a course in free-hand and elementary mechanical drawing, extending through the sophomore year.

The first term of the junior year, the student spends the time allotted to drawing in working out practical problems on the construction of gear teeth, cams, etc., and in elementary practice in line-shading and tinting.

The second term of this year is devoted to isometric projection, and the making of finished drawings in ink and in water colors. In the first term of the senior year, the student prepares an original design of some machine, makes working drawings of its details on tracing cloth, and finally prepares copies by the blue-print process. The afternoon work of the spring term consists of making calculations or designs of engines and boilers, the construction of the necessary working drawings, and making thesis drawings.

Theses are required of all students as a condition of graduation, and must be on some subject directly connected with mechanical engineering.

Students in this course receive the degree of bachelor of mechanical engineering upon graduation, with full degree of mechanical engineer three years afterwards upon presentation of a satisfactory thesis and proof of professional work or study.

RESULTS.

The results of the training received in this institution are shown by the following extracts from the report mentioned above:

"At the date of the establishment of the State College, it was estimated that 70 per cent. of the students graduated from existing colleges found their life's work in the liberal professions. The State College graduated its first class in 1872. The whole number of graduates to this date is 278. Of these less than 10 per cent. are embraced in the learned professions.

"A large proportion of the remaining 90 per cent. is engaged in the active business pursuits of the country. Many of them have attained positions of responsibility, trust and emolument, which only energy, intelligence and skill could have given them. It is a marked feature of the institution that its broad range of instruction and practice gives to its graduates the key to success without the intervention of a term of apprenticeship. Leaving the college, they at once become wage earners. It is true, also, of such instruction and practice that it often develops aptitudes in students for certain lines of employment of the existence of which neither themselves nor their most intimate friends had been conscious. Many a graduate, but a short time out of college, finds himself in some useful and honorable employment of which neither himself nor his friends had dreamed.

"The eminently practical character of the training they have received enables them to command positions of responsibility and trust without the delay of an intervening apprenticeship. A graduate said to the writer a few years ago that all the member of his class, includ ing himself, obtained honorable and lucrative employment within five months from the date of their graduation.

"During the early years of the college, fears that it would prove to be only an additional avenue to the 'learned professions' were often

expressed. Such fears have not been realized. Of its graduates less than 12 per cent. are found in the 'learned professions.' On the contrary, they are widely scattered among the institutions and industries of the country, where they are doing effective work as professors and instructors in colleges, as directors-in-chief and assistants in experiment stations, as teachers, as superintendents of public instruction, and of factories and farms, as engineers-in-chief of railroads, and engineers of divisions, as mechanical engineers in manufacturing establishments, as draughtsmen, designers, architects, government surveyors, mechanics and farmers, as veterinarians and superintendents of quarantine stations, and as agents at signal stations.

"Distributed through a range of employments so broad, it would be strange if there were not some failures. But the most gratifying assurances are multipying, each passing year, that the average of success of the graduates of the State College is larger than its most sanguine friends had ever claimed or even expected.

"Wherever found they illustrate the value of the training they have received. An officer of the college, who visited the McCormick manufacturing establishment at Chicago last summer, found three of its graduates who were doing all the draughting for a force of 1,800 men, and who had displaced in three years double their number, who had been doing the same amount of work. Measured by the money standard, there are graduates whose services are valued at from $3,000 to $6,000 per annum."

X. MARYLAND.

Baltimore Manual Training School.

An ordinance authorizing the establishment of a "School for Manual Training" in the city of Baltimore, under the control of the "Board of Commissioners of Public Schools," was passed by the city council, October 20, 1883.

"The school was opened March 3, 1884, with sixty students, being the first annual training school in the United States, established in connection with the city school system."

The object of the school is as follows: "Instruction and practice in the use of tools, and such instruction as may be deemed necessary in mathematics, drawing, and the English branches of a high school course. The tool instruction includes carpentry, wood-turning, patternmaking, chipping and filing, forge work, molding, soldering and brazing, the use of machine shop tools, and such other instruction of a similar character as may be deemed advisable to add to the foregoing from time to time, it being the intention to divide the working hours of the students as nearly as possible, equally between manual and mental exercises. This school differs from the city college in omitting from its required studies foreign and ancient languages, in giving prominence to mechanical drawing, and particularly in affording scientific instruction and actual practice in the care and use of tools.

"The school does not teach trades. Its aim is more comprehensive —it lays the foundation for many trades, and at the same time recognizes the value of intellectual discipline.

"It is not assumed that every boy who enters this school will be a mechanic. Some will find that they have no taste for manual arts, and will turn into other paths—law, medicine or literature. Some, who develop both natural skill and strong intellectual powers, will push on through the Polytechnic School into the higher realms of professional life, as engineers or scientists.

"Others will find their greatest usefulness as well as highest happiness in some branch of mechanical work into which they will readily step when they leave school. All will gain intellectually by their experience in contract with things. The general result will be an increasing interest in manufacturing pursuits, more intelligent mechanics, more skillful manufacturers, better lawyers, more skilful physicians, and more useful citizens."

Candidates for admission must be at least fourteen years of age, and must pass a satisfactory examination in reading, spelling,

writing, geography, English composition, and the fundamental operations of arithmetic as applied to intergers, common and decimal fractions, denominate numbers, and the extraction of the square and cube root of numbers. Ability to use the English language correctly is especially desired. Boys fourteen years of age who are members of the city college or pupils in the seventh grade of a grammar or "public school" for half a year or more will be admitted without examination upon recommendation of their principal.

The course of instruction covers three years and is as follows:

FIRST YEAR.

Arithmetic, algebra, geometry, mensuration, English language, history, geography, physiology and physics.

Drawing.—Geometrical and sketching.

Shop Work.—Carpentry, wood turning, forging, proper care and use of tools.

SECOND YEAR.

Algebra, geometry, plane trigonometry, mensuration, physics, history, English literature and mechanics.

Drawing.—Geometrical and mechanical or architectural.

Shop Work.—Patternmaking, vise work, welding, tempering, soldering and brazing.

THIRD YEAR.

Geometry, plane trigonometry, physics, mechanics, book-keeping, literature, chemistry, political economy, geology and engineering.

Drawing.—Machine, architectural and designing.

Shop Work.—Machine shop work, filing, turning, drilling, planing, etc., study of machinery.

Throughout the course, about one hour per day is given to drawing, and about two hours to shop work. The remainder of the school day is devoted to study and education.

The following list gives the shop work in detail:

FIRST YEAR.

Carpentry—Fifteen Weeks.

Care and use of tools: half lap and mortise and tenon, 1¼ by 1¼ by 4 inches; half lap joint, dovetail and mitre, 1¼ by 1¼ by 4 inches; dovetailing; a stool, 12 by 7 by 5½ inches; frame for door, 3 by 18 by 1 inches; scarf, three joints; knife box, 13 by 7¾ by 2⅝ inches; stairs, carriages, risers and steps; truss, rafters, with king and queen posts.

Wood Turning—Five Weeks.

Care and use of lathe—lectures; care and use of turning tools—lectures; cylinder between centers; cone between centers; step cylinder between centers; inverted cone between centers; geometrical piece in angles; geometrical piece in round; geometrical piece table leg; chuck work.

Course in Forge Shop.—Twenty Weeks.

Forge.—Mechanism of and care of forge and smith's tools, preparation of forge for fire, building and managing the fire, heat of fire, fluxes.

Tools.—Anvil, sledge, hand hammer, square tongs of various kinds. hot chisel, cold chisel, swages, fullers, flatters, formers, heading tools, mandrils.

Forging.—Forge square iron out of round, round out of square, octagonal out of square, hexagonal out of round, head up a rivet, head up a bolt.

Bending.—Turn a piece of flat iron to a right angle, the corners being brought square and neat, turn a flange, bend an eye, bend an ear, make a square out of a piece of flat iron.

Welding.—Make a jump weld, weld two pieces together forming a cross, make a split weld, a scarf weld, a pipe weld, bend and weld a washer of flat iron, make a round ring out of a piece of square iron, weld a square. make four or five links of a chain out of three-eighths round iron, iron to steel.

Tool Making.—Forge and finish a set of tools, a wedge, center punch, flat-nose calking tool, cape chisel, cold chisel, a drift, heading tool calipers, straight-edge, tee square, hand hammer, set of drills, set of lathe tools, make and finish a (cross pene) fitter's hammer, a (cross pene) chipping hammer, a (straight pene) chipping hammer, a (round pene) blacksmith's hammer.

Tempering.—Theory of tempering, temperatures and colors, water, oil, etc. Temper chisels, turning and boring tools for wood and metals.

SECOND YEAR.

Patternmaking—Fifteen Weeks.

Care and use of tools. Lectures.

Gib.
Crank.
Cylinder head.
Connecting rod brasses.
Piston head.
Piston rings.
Cross head.
Cross head guide.
Engine Frame.
Cylinder.

} Complete set of patterns for a steam engine.

Molding—Five Weeks.

Care and use of molders tools, lectures; crucibles, furnaces and cupolas, lectures; green sand, dry sand, loam.

Vise Work—Fifteen Weeks.

Care and use of tools, lectures; square prism rectangular block with champered edges, octagonal prism, rack teeth, right angle piece, anvil (free hand filing), elipse, circle and segments, riveting, hammer (free hand filing), ring, slide rest, open slot piece, gear wheel, inlaid plate, parallel filing, tongue and groove, dovetail, screw (free hand filing), geometrical form, key way and champer.

Soldering and Brazing—Five Weeks.

The names and qualities of the various metals used; degrees of heat necessary for soldering, brazing, tinning, burning; the proportions of metals in order to produce the best results; the modes of applying heat in soldering, brazing, tinning, burning; method of overcoming difficulties caused by overheating; method of burning metal together; preparation of metals for soldering, brazing, tinning and burning; exercises in the process of uniting the edges or surfaces of similar or dissimilar metals and alloys by partial fusion.

The course familiarizes the student with the tools of the metal worker, and prepares him for the construction of work from drawings.

THIRD YEAR.

Forty Weeks.

Machine shop work; names, uses and care of hand and machine tools—lectures; machine shop methods—lectures; finish up castings and forgings of former lessons; finish up a design for graduation.

A course in mechanical engineering was added in 1888. There is also a preparatory department connected with the institution, to which boys who are pupils in the sixth grade of a grammar or "public school" for half a year or more, are admitted without examination, upon recommendation of their principal.

The course of study, covering two years, is as follows:

FIRST YEAR.

Language; reading; writing; arithmetic; algebra; geometry; geography; history of United States. Drawing—forty-five minutes each day. Sketching from models—free-hand drawing. Map of Maryland and of the United States.

Wood Work—Seventy five Minutes each Day—Twenty Weeks.

Care and use of tools; to lay off work; ripping and cross-cutting; planing trueing and bringing lumber to a width and thickness; nailing.

Mortise and tenon; blind mortise and tenon; half lap joints; through mortise and tenon rabbeted; dowel joints, plain box (6x4x2 inches) nailed together.

Sheet Metal Work—Seventy-five Minutes each Day—Twenty Weeks.

Care and use of tools; how to make and care for the fire in a charcoal furnace; how to lay off the work. Soft solder.

Solder two pieces of tin together; groove and solder a seam; plain pipe, 6 inches long, 2 inches diameter; rectangular pan, 4x8x1½ inches deep; square pipe, 6 inches long, 2 inches square; square box, with loose top, 4x2x2 inches; round pan, 4 and 5 inches diameter, 1½ inches deep; elbow, right angle, 6–6x2 inches deep; tin cup, 3½ inches diameter 2 inches deep; butter kettle, 8x5x5 inches deep; tea or coffee pot, 3½—4 inches diameter 6 inches deep.

SECOND YEAR.

Language; reading; writing; arithmetic; geography; history; algebra, geometry. Drawing forty-five minutes each day; free-hand and maps.

WOOD WORK.

Seventy five Minutes each Day—Twenty Weeks.

Care and use of wood-worker's bench tools, bracket saw and foot-lathe.

Bracket; combination bracket; easel; fancy frame; turning cylinder, cone, truncated code, step cylinder, geometrical form, round form, table leg.

SHEET METAL SHEET.

Seventy-five Minutes each Day—Twenty Weeks.

Care and use of tools and how to lay out work; make and care for fire in furnace; hard solder; tin a piece of brass, tin a piece of copper; joint together copper to copper, brass to brass, copper to brass, copper to iron; make a piece of copper pipe six inches long, three-fourths of an inch in diameter; elbow, right angled, 4–4x¾ inches in diameter; copper bowl, beaters, six inches in diameter three inches deep; a brass vase, beaten in halves and brazed together eight inches high; a copper vase, fluted, eight inches high; a checker board table, copper and brass; hemisphere of copper, beaten, six inches in diameter; a brass vase, beaten and brazed together, eight inches high; copper vase, fluted, eight inches high; a checker board table, brass and copper.

RESULTS.

The following extracts from the annual report of the principal in December, 1887, will show some of the results of the work:

The first class was graduated in June, 1887. Of the twenty five young men composing it, " one is an instructor in the school, one civil engineer, two electrical engineers, one marine engineer (now at sea), one house carpenter, two patternmakers, one draughtsman, one farmer, one car-builder, one machine supply store, one architect, six machin-

ists, one student, and two are in mercantile pursuits, all with bright prospects for a useful and properous future.

"Of the fifty-five students who have been withdrawn from the school during the year, all but six are following mechanical pursuits.

"The course of study and shop work as indicated above has been strictly adhered to and the results are satisfactory. * * *

"The nine by twelve inch cylinder steam engine which was built by the members of the graduating class, from their old drawings, was set up in the shops in the place of the old one. It does the full work, is noiseless in its operation and has proven that it was well made and correctly adjusted."

The growth of the school has been.

Students on roll March, 1884,	62
Students on roll June 30, 1884,	100
Students on roll December 31, 1884,	147
Students on roll June 30, 1885,	112
Students on roll December 31, 1885,	94
Students on roll June 30, 1886,	110
Students on roll December 31, 1886,	150
Students on roll June 30, 1887,	204
Students on roll December 31, 1887,	273

XI. MASSACHUSETTS.

1. Boston Public Schools.

The subject of manual training in connection with the public schools of Boston had been actively discussed for several years previous to 1883, when it was made the subject of special report by a committee chosen for that purpose.

The committee outlined a plan and submitted the following orders:

Ordered, That the city councils be requested to appropriate the sum of $2,500 for the equipment and maintenance of a manual training school.

Ordered, That the city council be requested to fit up rooms in the basement of the Latin school building, where classes from the grammar schools can be instructed in the use of simple hand-tools during the ensuing school year.

In April, 1884, eleven classes, containing in all two hundred and twenty boys from ten grammar schools, had insruction in carpentry once a week. The lesson was two hours long, and boys were allowed to stay a part or the whole of a third hour if they desired. The boys were fourteen or more years old, and members of the first and second classes in the grammar schools. Accommodations were provided in the basement of the Latin school building.

The progress of the work is shown in the report of the superintendent of public schools, issued in March, 1885.

"The experiment in manual training for boys has made interesting progress. Two hundred boys from ten different grammar schools have been under instruction in carpentry two hours a week since September. Most of them were beginners at that time, but a few were members of the classes formed last April. The boys were selected by the masters of the grammar schools, no boy being taken who was not fourteen years old, and who had not the expressed permission of his parents to take instruction. This limit as to age is well suited to the usual size and strength of boys, and has the additional advantage of avoiding some possible legal difficulties.

"A course of lessons drawn up at the beginning of the year by the teacher, has been followed with some approach to uniformity; but here, as everywhere else, widely different degrees of native aptitude, as well as of attention to instruction, show themselves among the boys. There are some whose 'fingers are all thumbs;' and there are others who make square work and good joints almost from the beginning. A very little observation among the boys is enough to show that a clear mind generally accompanies the skilful hand that manual skill

has its mental as well as its physical side, and that manual training is really a means of mental training.

"The interest in their work shown by the boys is very lively, such as I have seldom seen surpassed in any other kind of school-work. Many boys come to the shop afternoons, an hour before the appointed time, and get the teacher's permission to work three hours instead of two. Some, seeing the gas-fixtures provided for use on dark days, and fancying that instruction was going to be given in the evening, begged to be allowed to come and work then, as well as in the day-time. But there were others, of course, whose ardor cooled as the novelty wore off, and the truth began to dawn upon them that manual training was after all work and not play. Still the number of these last was not large enough to disturb the generally favorable impression the classes produced.

"The experiment has already gone far enough to prove that work of this kind can be joined to the ordinary grammar school work with good effect. It enlisted the sympathy, encouragement and support of the masters from the beginning; and to this cause the success already achieved is largely due. So long as there are nearly three thousand boys in the grammar schools, fourteen, fifteen or more years old, it will be desirable to give them good opportunities to discover and improve their mechanical aptitudes, and thus to gain a mental discipline which otherwise they would miss. But where is the time for a new branch of instruction? The answer has been given that manual training, being a kind of physical exercise, is a relief from other school-work, and therefore a boy will do all his regular studies and the shop work too in the time usually given to the former. This answer can be defended to some extent by an appeal to experience. Still it is taking rather high ground to say that manual training can be added to the branches of instruction now pursued without diminishing the latter. I would rather take a more moderate position and pay due regard to the averge possibilities. It would be wiser to make room for a new branch of instruction by dropping some of the old. For example, if the question were between physics, as commonly taught out of a book, on the one hand, and instruction in carpentry on the other, I should unhesitatingly prefer the latter. Indeed, by means of the latter, we might be able to get some real instruction in the former. The time given to carpentry would not be wholly a loss to the other studies, for some of them, as drawing and the geometrical part of arithmetic would be aided.

"The manual training practicable in school rooms seems to be limited to those kinds of work which can be done at a bench with hand tools. Within this limit the way now seems clear to spread instruction among the schools, as far as may be thought desirable. While I am more than gratified with the progress thus far made I, nevertheless, deem it important to remember that a fully equipped manual training school

will find its proper place in the school system, not in the grammar schools, but above them, and side by side with the high school; and I trust that the means may be found ultimately for carrying out the full plan."

The lessons in carpentry, in detail, were as follows:

Lesson I.—A board four feet long and twelve inches wide, of undressed lumber. By the use of chalk and line strike off two or three spaces three-qnarters of an inch apart for the use of splitting saw. With the rule and pencil mark off five or six three-quarter inch spaces, and square across with the try-square, for the use of cutting-off saw. After using these tools what remains of the board is to be cut into pieces of the right dimensions for a box fourteen inches long, six inches wide, and four inches deep. The purpose of this lesson is to teach the use of the splitting and cutting-off saws.

Lesson II.—This lesson brings into use the different bench planes. First, remove the iron from the frame, grind it on the grindstone if necessary, whet it on the oil-stone, and then adjust for use. Taking the stock cut for a box in the last lesson, plane one side and one edge of the board square; then gauge with the marking-gauge, and plane to four inches in width, squaring ends with the butt-plane, and nail together.

Lesson III.—Get out stock two inches wide and seven-eighths of an inch thick, and put together a box twelve inches long and six inches wide, by mitering the ends or cutting them at an angle of forty-five degrees.

Lesson IV.—A miter-box. Stock eighteen inches long. Bottom planed to four inches wide. Take out of wind by use of straight-edge. Sides five inches wide, and nailed to the bottom. Cut with a saw across the two sides, at an angle of forty-five degrees, to the right and to the left.

Lesson V.—Saw and plane some stock three inches wide, and put together a box by cutting the ends in the miter-box. This lesson is to test the miter-box. If correct, the ends of the box will come together square.

Lesson VI.—Stock two inches wide, with a rabbet cut for glass and the two edges beaded, mitered, and dowelled together for a picture-frame. This affords another test of the miter-box.

Lesson VII.—Take two pieces of board, each six inches long and five inches wide, planed and squared, and put together by a common dovetail joint.

Lesson VIII.—Take two pieces of board, each six inches long and five inches wide, and put them together by blind dovetailing.

Lesson IX.—A small cabinet, nine inches square, halved together, with two drawers put together by blind dovetailing. Cross-bar between the two drawers dovetailed in. Made of black walnut or of whitewood.

Lesson X.—A chest two feet long, twelve inches wide, and twelve inches deep, dovetailed and glued together, the bottom fitted inside. Base three inches wide, chamfered on the upper edge and mitered together at the corners. Trimming around the top beaded, two inches wide, and mitered together at the corners.

Lesson XI.—Make a mortise and tennon, and fit them together. This is a preparation for the next lesson.

Les on XII.—Cover for the chest (Lesson X). Put together with mortise and tenon, with a panel in the center.

Lesson XIII.—A writing-desk, twelve inches long, nine inches wide, three inches deep, at the back, and one inch and a half deep in front, with compartments for pens and ink. Cover put on with hinges.

Lesson XIV.—Stock three inches wide, two inches thick, and six inches long, framed together with a key-tenon.

Lesson XV.—Table with a drawer. Top three feet long and one foot eight inches wide, made of two boards glued together. Frame put together with mortise, tenon, and draw-bore. Cross-pieces six inches wide. Legs square and tapering.

The tools at each bench were: Splitting-saw, cutting off saw, fore-plane, short jointer, smoothing-plane, butt-plane, hammer, mallet, rule, try-square, bevel, marking-gauge, mortise-gauge, five auger-bits and a brace, five firmer-chisels, screw-

driver, counter-sink, brad-awl, scratch-awl, nail-set, chalk-line and reel, oil-stone, oil-can, bench-brush.

A few tools in addition to those at the benches are furnished, when needed, to individuals.

In 1886 the Superintendent reported: "The interest is unabated, and the progress of the two hundred boys with their work is even more satisfactory this year than it was last. The course of lessons has been improved; some of the articles made last year having been replaced by others better adapted to the purpose of giving the best training possible in the limited time.

"The experiment has now gone far enough to prove that this kind of training can be joined with the ordinary grammar school work without practical inconvenience, and with good effect on the boys. There have been calls from other parts of the city for similar schools to be opened there, and the promise is that one more will be started in September.

"One fact, noticed in the last committee's report, is significant, and that is, the lively desire shown on the part of last year's boys to continue in the school this year; which, however, they could not be allowed to do, being then graduates of the grammar schools. There is no doubt that boys once engaged in a course of manual training will, as a rule, conceive a strong desire to keep on. The consciousness of new power awakened and trained for practical ends, is very gratifying to them. Indeed, we find among these boys just what the psychologist would have led us to expect—a class of minds which can be reached in no other way so well as through their mechanical aptitudes. It seems certain if a school with an extensive course of manual training should be opened, there would be no lack of interested pupils to fill it. That there are many parents who would appreciate the value of such a scoool for the training of their boys is plainly enough indicated by the manifestations of parental interest in what is being done now."

Through 1887 the course was substantially the same, there being no chance for advancement in carpentry work until better accommodations could be secured. These, however, were looked for in the near future.

2. Massachusetts Institute of Technology.

The foundation of the Massachusetts Institute of Technology was laid in a report by Professor William B. Rogers, entitled "Objects and Plan of an Institute of Technology, including a Society of Arts, a Museum of Arts, and a school of Industrial Science." A charter for the institution thus projected was granted by the Legislature of Massachusetts in an act dated April 10, 1861. In this charter, the threefold plan outlined by Professor Rogers, who became the first president of the Institute of Technology, was preserved.

The School of Industrial Science, developed along the lines indi-

cated at its foundation, has become the prominent feature of the work of the institute; and indeed, nearly all persons know it, and it alone, as the institute. The school was opened in February, 1865, with twenty-seven pupils. It is devoted to the teaching of science as applied to the various engineering professions, viz: civil, mechanical, mining, electrical and chemical engineering, as well as to architecture, chemistry, metallurgy, physics and natural history. Courses of a less technical nature, designed as a preparation for business callings, and a course preparatory to the professional study of medicine, are also given.

COURSES OF INSTRUCTION.

The School of Industrial Science of the Massachusetts Institute of Technology provides an extended series of scientific and literary studies, and of practical exercises. The courses of study include the physical, chemical and natural sciences and their application; pure and applied mathematics; drawing; the English, French, German and other modern languages; history; political science; and international and business law; These studies and exercises are so arranged as to afford a liberal and practical education in preparation for active pursuits, as well as a thorough training for most of the scientific professions.

Regular Courses.—The following regular courses of study, each of four years' duration, have been established; and, for proficiency in any one of them, the degree of Bachelor of Science, S. B., in the course pursued is conferred.

I. Civil and topographical engineering.
II. Mechanical engineering.
III. Mining engineering.
IV. Architecture.
V. Chemistry.
VI. Electrical engineering.
VII. Natural history.
VIII. Physics.
IX. General course.
X. Chemical engineering.

The first year for all courses is the same, and contains subjects which are considered essential as preliminary training, or as a foundation for the more strictly professional studies of the later years of all courses. At the end of the first year, the regular student selects the course which he will pursue during the remaining three years; and his work becomes more specialized thereafter as it progresses.

The studies of the first year are as follows:

FIRST TERM.	SECOND TERM.
Solid Geometry.	Plane and Spherical Trigonometry.
Algebra.	General Chemistry.
General Chemistry.	Chemical Laboratory.
Chemical Laboratory.	Political History since 1815.
History of the English Language.	French (or German).
English Composition.	Mechanical and Free-hand Drawing.
French (or German).	Millitary Drill.
Mechanical and Free-hand Drawing.	
Military Drill.	

To be admitted as a regular student in the first year's class, the applicant must have obtained the age of seventeen years, and must pass a satisfactory examination in arithmetic, algebra, plane geometry, French, English language and literature, history and geopraphy.

Every student is required, on entering, to file a bond in the sum of $200, as security for the payment of bills. If, for any reason, such a bond cannot be obtained, a deposit of fifty dollars, as security, is accepted.

The tuition fee for regular students is $200 per year.

To be admitted to a more advanced class the applicant must be of correspondingly increased age and must in general pass satisfactorily the examination for admission to the first year's class, and examinations on all of the subjects given in the early years of the course which he desires to enter.

Graduates of colleges are admitted to the institute without examination, and are permitted to enter any of the courses at such a point as their previous range of studies allows.

Within each of the regular courses the student is given a considerable latitude of choice in the selection of the branch of his intended profession to which he will specially devote his energies in the later years of his study. This is accomplished by means of lines of options. Thus in civil engineering, he may elect either sanitary engineering, railroad engineering and management, or geodesy; in mechanical engineering, he may choose either marine engineering, locomotive construction, or mill engineering; and similarly for other courses.

The course in mechanical engineering aims to equip the student with such training in pure and applied mathematics as shall qualify him to deal with the engineering problems of his profession from the most favorable standpoint. It attempts by instruction, both theoretical and practical, to acquaint him with engineering practice, and to give him a proper groundwork upon which to base a professional career. The more strictly professional work of the course may be classified as follows:

1. Mathematics, physics and applied mechanics, given outside the department; the last including the study of and practice in testing the strength of materials.

2. Recitation-room work of the department proper, beginning with

a study of the principles of mechanism, the construction of gear-teeth, etc., and continued by courses on machine tools and cotton machinery. Courses are given on the slide-valve and link, thermo-dynamics, theory of the steam engine, and on steam boilers. The fourth year instruction includes such mechanical engineering subjects as dynamometers, governors, fly-wheels, springs, effects of reciprocating parts of engines, injectors, steam-pumps, cylinder condensation, hydraulics and hydraulic motors, etc. An option is given among courses on marine engineering, locomotive construction and mill engineering.

3. Drawing-room work. The students in the second year make working-drawings from measurements, and the drawings necessary in connection with the course in mechanism and gear construction. In the third year they make detail and assembly drawings from machinery, and this is followed by mechanism designs and boiler drawings. In the fourth year a course in machine designs is given.

4. Shop work, including carpentry, patternmaking, forging, chipping, filing and machine-tool work.

5. Mechanical engineering laboratory work. This begins with drill in steam engine tests in the second term of the third year, and is continued throughout the fourth year, including tests of boilers, pumps, power, etc., and a large amount of investigation.

The course in detail is as follows:

FIRST YEAR.

[Same for all courses, as given above.]

SECOND YEAR.

FIRST TERM.	SECOND TERM.
Principles of Mechanism.	Mechanism of Mill Machinery.
Construction of Gear Teeth.	Mechanism of Shop Machinery.
Drawing.	Drawing.
Carpentry and Wood Turning (shopwork).	Pattern Work (shopwork).
Analytic Geometry.	Differential Calculus.
Descriptive Geometry.	Physics.
Physics.	English Prose.
Political Economy.	German.
German.	

THIRD YEAR.

FIRST TERM.	SECOND TERM.
Slide Valve. Link Motion.	Steam Engineering.
Thermo-dynamics.	Drawing, Design and Surveying.
Steam Engineering.	Mechanical Engineering Laboratory.
Drawing, Design and Surveying.	Forging, Chipping and Filing (shopwork).
Forging (shopwork).	Kinematics and Dynamics.
Integral Calculus.	Strength of Materials.
General Statics.	Physical Laboratory.
Physics: Lectures and Laboratory.	European History.
German.	German.

FOURTH YEAR.

FIRST TERM.

Mechanical Engineering.
Hydraulics.
Machine Design.
Mechanical Engineering Laboratory.
Engine Lathe Work (shopwork).
Strength of Materials.
Metallurgy.
Heating and Ventilation.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.

SECOND TERM.

Hydraulic Engineering.
Mechanical Engineering Laboratory.
Engine Lathe Work (shopwork).
Strength and Stability of Structures.
Theory of Elasticity.
Constitutional History.
Thesis Work.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.

The instruction in theoretical and applied mechanics begins with the study of the composition and resolution of the forces, the general laws of kinematics and dynamics, mathematically discussed, the principles governing the determination of the stresses in the different members of trusses, center of gravity, moment of inertia and the ordinary principles of the strength of materials.

The more advanced part of this instruction embraces the completion of the study of strength of materials, including laboratory work, theory of elasticity, main principles of the stability of arches and domes and special study of dynamics.

The methods of the differential and integral calculus are freely used whenever they are the most convenient.

The object of the laboratory of applied mechanics is to give to the students, as far as possible, the opportunity of becoming familiar, by actual test, with the strength and elastic properties of the materials used in construction.

It is furnished with the following apparatus:

1. An Olsen testing machine of fifty thousand pounds capacity, capable of determining the tensile strength and elasticity of specimens not more than two feet long, and the compressive strength of short specimens.
2. A testing machine of fifty thousand pounds capacity, capable of determining the transverse strength and stiffness of beams up to twenty-five feet in length, as well as many of the framing joints used in practice.
3. Machinery capable of determining the strength, twist and deflection of shafting when subjected to such combinations of torsional and transverse loads as occur in practice, and while running.
4. Machinery for making time-tests of the transverse strength and deflection of full size beams.
5. A machine for testing the tensile strength of mortars and cements.
6. Apparatus for testing the strength of ropes.
7. The accessory apparatus needed for measuring stretch, deflection and twist.

The classes are divided into small sections when making tests with the machines.

All the experiments are so chosen as to make the student better acquainted with the resisting properties of materials, many of them forming part of some original research. Those on transverse strength

and stiffness have also determined certain constants for use in construction which had not previously been determined from tests on full size pieces.

The instruction in mechanical engineering is given by means of lectures and recitations and by practice in the drawing rooms and in the mechanical engineering laboratory. Frequent visits, also, are made to machine shops and manufacturing establishments to witness machinery in operation and manufacturing processes, in addition to those which can be seen at the institute itself.

The laboratory work, in its earlier portions, is devoted to some of the more simple experiments, such as will impart to the students a familiarity with the manner of running the engines, taking indicator cards, and using the other apparatus in the laboratory. The later laboratory work takes very largely the form of original research, and it is intended that the students of this laboratory shall, under suitable direction, undertake the experimental investigation of a number of important engineering problems.

A large amount of drawing is done by the students throughout their course in connection with their regular work, drawing for mere practice ceasing at the end of the first year. A style is adopted that is believed to be a good one, and it is adhered to throughout, and early in their course the students are taught to use the "Blue process."

Besides the teaching done by the regular corps of instructors, lectures on special subjects are given by gentlemen actively engaged in the profession.

The objects to be accomplished by the laboratory of mechanical engineering are the following:

1. To give to the students practice in such experimental work as they are liable to be called upon to perform in the practice of their profession, as boiler and engine tests, pump tests, calorimetric work, measurement of power, etc.

2. To give to the students practice in carrying on original investigations in mechanical engineering subjects with such care and accuracy as to render the results of real value to the engineering community.

3. By publishing, from time to time, the results of such investigations, to add gradually to the common stock of knowledge.

The laboratory contains, as a portion of its equipments:

1. An eighty-horse power Porter-Allen engine, by which power is also furnished to the new building and to the mining department.

2. A sixteen-horse-power Harris-Corless engine, used almost entirely for experimental purposes. This is furnished, in addition to its own automatic cut-off governor, with a throttle governor, so arranged that either can be used; the former being, in addition, so constructed that the speed of the engine can be varied at will.

The exhaust of each engine is connected with a surface condenser, and thence with a tank on scales, so that the water passing through the engines can be weighed.

3. An eight-horse-power steam engine used for giving instruction in valve-setting, etc.

4. Three surface condensers, one of which is arranged in sections, so that the condensing water can be made to transverse the length of the condenser, once, twice, or three times, at the option of the experimenter.

5. Machinery for determining the tension required in a belt or rope to enable it to carry a given power, at a given speed, with no more than a given amount of slip.

6. Several friction brakes.

7. A steam pump so arranged as to enable the students to make pump tests, indicating both the steam and the water cylinder, weighing the exhaust steam, and also the water pumped.

8. A six-inch Swain turbine-wheel, so arranged that it can be run under a head of fifteen feet, and that experiments can be made on the power exerted, the efficiency, etc., under different gates.

9. Several calorimeters of different kinds,

10. Two transmission dynamometers.

11. Cotton machinery as follows, viz: two cards, drawing frame, a speeder, a fly-frame, a ring-frame, and a mule.

12. Apparatus for testing injectors.

13. A mercurial pressure column.

14. A mercurial vacuum column.

15. Apparatus for determining the quantity of steam issuing from a given orifice, or through a short tube, under a given difference of pressure.

16. Apparatus for testing dynamometers.

17. A good supply of indicators, planimeters, gauges, thermometers, and anemometers and assessory apparatus.

18. Two horizontal tubular boilers and a large Babcock & Wilcox boiler.

Another boiler, a forty horse-power Brown engine, a number of looms and other apparatus in the mechanical laboratories on Garrison street, are available for the purpose of experiment.

As examples of the work done in the laboratory, the following experiments are enumerated: Tests of the evaporative powers of boilers; tests of the effects of different cut-off, compression, back pressure, speed, etc., of engines under constant or variable loads; calorimetric tests; dynametric measurements; investigations of the tension required in a belt to carry a given power, at a given speed, with no more than a given amount of slip; experiments on the efficiency of condensers under different conditions; on the efficiency of a turbine, etc.

The instruction in shopwork.—Practical instruction in the nature of the materials of construction, and the typical operations concerned in the arts, is considered a very valuable adjunct to the theoretical treatment of professional subjects. Mechanical laboratories have been provided, and furnished with the more important hand and machine tools, so that the student may acquire a direct knowledge of the nature of metals and woods, some manual skill in the use of tools, and a thorough knowledge of what can be accomplished with them. These laboratories are now located in the building on Garrison street, and are equipped as follows:—

The carpenter, wood-turning, and patternmaking departments contain 40 carpenters' benches, 2 circular-saw benches, a swing-saw, 2 jig-saws, a buzz-planer, a mortising machine, 36 wood lathes, a large patternmakers's lathe, and 36 pattermakers' benches. The foundry contains a cupola furnace for melting iron, 2 brass furnaces and 32 moulders' benches. The forge shop contains 32 forges, 7 blacksmiths' vises

and 1 blacksmith's hand drill. The machine-shop contains 23 engine lathes and 14 hand lathes of recent approved patterns, 2 machine drills, 2 planers, a shaping machine, a universal milling-machine, a grinding lathe, and 33 vise-benches arranged for instruction in vise-work.

3. Cambridge Manual Training School.

The experiment of giving instruction in manual training to the pupils of the public school has been tried in a limited way for the past four years. Annually seven classes of twelve pupils each, selected from the seven grammar schools, have received elementary instruction in carpentry.

"Undoubtedly there is no school question more prominently before the community at the present time than that of making manual training a branch of instruction in the common schools; and in Cambridge this question has assumed special importance since Mr. Frederick H. Rindge made to the city his generous offer of an industrial school building ready for use, together with a site for the same.

"The object and aim of the school as proposed by him are best made known in his own words. He says: 'I wish the plain arts of industry to be taught in this school. I wish the school to be especially for boys of average talents, who may in it learn how their arms and hands can earn food, clothing and shelter for themselves; how, after a while, they can support a family and a home; and how the price of these blessings is faithful industry, no bad habits, and wise economy, which price, by the way, is not dear. I wish also that in it they may become accustomed to being under authority, and be now and then instructed in the laws that govern health and nobility of character. I urge that admittance to said school be given only to strong boys who will grow up to be able workingmen.

"Strict obedience to such a rule would tend to make parents careful in the training of their young, as they would know that their boys would be deprived of the benefit of said school unless they were able-bodied. I think the industrial school would thus graduate many young men who would prove themselves useful citizens.'

"It becomes the duty and privilege of the school committee to co-operate in carrying out his plans so far as the industrial school is to be brought into connection with the public school system. For this purpose the committee has sought information in regard to the oganization and work of the industrial schools of our country, and more especially in regard to the work of manual training as connected with the public schools."

4. Springfield Manual Training School.

"The experience of Springfield is a fairly typical one, and it will be found to give an answer to the many questions which are continually asked, such as, how much will a wood-working department cost?

what pupils should attend? and, will it interfere with the children's other studies?

"It has been and will continue to be the aim of the committee to bring the course of study in the schools into harmony with the best and most practical educational methods known in order that the analytical, reasoning and constructive powers of the scholars may be developed, that they may become familiar with practical things, and leave school, when circumstances compel them to join the great army of workers, equipped with knowledge, so far as it goes, that will be useful to them in whatever honest occupation they may follow. As nearly ninety-five per cent. of the scholars who go out from the schools will from necessity become engaged in some kind of manual labor, it is important that manual training should have an established place in our school system, not for the exclusive benefit of those who are destined to lives of toil, but also for those who may be called to enter the learned professions. It has been truly said that 'mannal training is essential to the right and full development of the human mind;' therefore, the young man or woman who encounters the world with only the mind trained is not fully equipped to commence either a mechanical, scientific, business or professional career. Impressed with the importance of these truths, the committee has taken steps in a modest way to introduce into the schools manual in connection with mental training.

"To establish a school for manual training required a special appropriation from the city government, as the public statutes do not allow industrial schools to be maintained from money appropriated for general school expenses. The committee considered it their duty to make a beginning in this direction, and on March 1st petitioned the city government to appropriate one thousand dollars to equip an experimental industrial school and employ a competent teacher to conduct it. The appropriation was promptly made, the basement of the high school building was selected as the most suitable place at the command of the committee, and an instructor was engaged. Attendance at the manual training school could not, under the law, be made compulsory, and volunteers were called for from the freshman class of the high school, and the eighth and ninth grades of the grammar schools; that the boys should not be less than thirteen years of age was the only condition of admission.

"Eighty-four boys manifested their desire to be enrolled for the term beginning in september, and eighteen of them expressing a wish to receive instruction during a summer vacation, were formed into two classes, and three lessons a week for four weeks were arranged. Thirteen benches designed for wood working were obtained and equipped with suitable tools for the class of work to be taught; three large cupboards, each containing thirty-two compartments, were provided for the convenience of the pupils. The school opened on July

12th with the two vacation classes, which by this time had received recruits, increasing the number to twenty-two scholars. The fall term opened with an enrolment of ninety-one scholars, which number soon increased to ninety-six, and these were divided into eight classes of twelve scholars each. It was arranged that each class should receive one lesson a week of one and one-half hours' duration, and the instructor was employed to devote three days a week to the school, as the amount of the appropriation did not warrant the committee in engaging his full services. The course of instruction arranged consisted of fifteen lessons, divided into forty-five problems, covering the use of the hammer, nail driving, measurement, use of the try-square, gauging, sawing to line, cutting to length, cutting to width, shelf making, box making, use of dividers, boring, use of brad awl, use of chisel, examples in construction, and the general use of carpenter's tools, their parts described and defined, their adjustment explained, and the pupils taught to keep them in working order. On November 9th an additional class was organized for Saturday afternoons, consisting of twelve scholars from private schools.

"The Saturday morning class has among its members four of the grammar school principals and the drawing teacher. This fact is mentioned to show the interest manifested in manual training by many of our most accomplished instructors.

"The cost of the experimental training school, from its establishment to January 1, is as follows:

Cost of equipment,	$503 19
Cost of material,	60 11
Salary of instructor,	231 14
Balance of appropriation not used,	205 56
Total,	$1,000 00

"The remainder of the appropriation will carry the school on the present plan until March, 1887.

"In view of the encouraging results of the experiment as far as it has been carried, the committee venture to suggest that the incoming city government make an appropriation of five thousand dollars, in order that the scope of the school may be extended to include wood turning and metal working in some of its simpler branches, and that full time of the present instructor be secured for the work.

"The basement of the high school is not a suitable place for the continuance of the experiment, owing to dampness and insufficient light; and a light, dry, well ventilated work-room, with the privilege of power, will be required. It is believed that five thousand dollars will cover the expenses of the instructor, supply additional tools and materials, and pay the rent for room and power. The tools and equipment now owned by the city, and all that may be bought as suggested, will come into play in case the experiment develops into a permanent

part of the school system. It is the testimony of the principals of the high school and the grammar schools that the time given to manual training has not retarded the pupils in their regular studies.

"The committee cherish the hope that in the near future the liberal citizens of Springfield will provide for the use of the city, under proper regulations, suitable buildings in which at least one hundred pupils can receive simultaneous mental and manual training. The cost of such buildings, exclusive of land, fully equipped with all the appliances for instruction in wood and metal working, need not exceed forty thousand dollars. Pupils for such a school should not be less than thirteen years of age, selected for merit after passing grade eight in the grammar schools, or with the same requirements if taken from parochial or private schools. They should be given a three years' course in manual training in connection with regular studies, consisting of mathematics, drawing, the sciences, and the English branches of the high school course. The manual training department should include instruction in carpentry, patternmaking, wood-turning, filing, forging, brazing, soldering and the use of machine shop tools. The time of the pupils should be equally divided between mental and manual exercises. It is a remarkable fact, established by experience in manual training schools, that scholars who devote half of their study hours to manual exercises make equal progress in mental work with those who give all their study hours to it. The cost of maintaining a school of this general character would not greatly exceed the cost of high school instruction, which in this city was thirty-six dollars per capita for the year 1886. Fifty dollars per capita ought to pay the expenses of maintaining a manual training school of one hundred pupils.

"The object in establishing such a school is not to train apprentices and teach trades, but to drill pupils in the fundamental mechanical principles that are the basis of all trades, and "to foster a higher appreciation of the value and dignity of intelligent labor, and the worth and respectability of laboring men. Its graduates will become intelligent workingmen, producers of wealth, developers of the inexhaustible resources of our country, and the promoters and defenders of that peculiarly American civilization which is destined, in God's providence, to lead the world in every art and industry."

The course of study and shop-work is as follows:

SENIOR GRAMMAR SCHOOL YEAR.

Elementary course in the use of wood-working tools. Tools described and adjustment of parts explained. Rules of mechanics.

FIRST HIGH SCHOOL YEAR.

Fall Term.

Academic Studies—Algebra; Physiology, followed by Physics; English Language.
Shop Work—Joint Making, Sand-papering, Staining and Varnishing, Grinding and Honing Tools, Lectures on Grain of Wood.
Drawing—Shop Drawings, Principles of Projection, Use of Instruments.

Winter Term.

Academic Studies.—Algebra, Physics, English Language.

Shop Work.—Wood-Turning, Scraping, Polishing; Lectures on Kinds of Wood and their Uses.

Drawing.—Shop Drawings, Pen Lining, Lettering, Simple Objects Measured and Drawn to Scale, Perspective Drawing from Models and Objects.

Spring Term.

Academic Studies.—Algebra, Physics, English Language.

Shop Work.—Carving, Saw-Filing.

Drawing.—Shop Drawings; Instrumental Drawings of Details and the Whole of Simple Machines from Figured Free-hand Sketches; Outdoor Sketching.

SECOND HIGH SCHOOL YEAR.

Fall Term.

Academic Studies.—Geometry, General History, Zoology, fourteen weeks, followed by Physical Geography.

Shop Work.—Forging, Welding, Tempering.

Drawing.—Shop drawing, Geometric Problems, Orthographic Projection, Perspective Drawing, Study of Light and Shade.

Winter Term.

Academic Studies.—Geometry, General History, Physical Geography, twelve weeks, followed by Botany.

Shop Work.—Soldering, Brazing, Pattern Making, Lectures on kinds of metal and their Uses.

Drawing.—Pattern Drawing, Isometric Projections, Flat Tinting, Architectural Drawing, Historic Ornament.

Spring Term.

Academic Studies.—Civil Government, Elementary Chemistry, Botany.

Shop Work.—Pattern Making, Moulding, Casting.

Drawing.—Pattern Drawing, Architectural Drawing, Outdoor Sketching, Architectural Details.

THIRD HIGH SCHOOL YEAR.

Fall Term.

Academic Studies.—Rhetoric and English Literature, Higher Algebra, Chemistry, French or German.

Shop Work.—Chipping and Filing Metals.

Drawing.—Line and Brush Shading, Pen and Ink Sketching, Shop Drawings.

Winter Term.

Academic Studies.—Rhetoric and English Literature, Algebra completed, Higher Geometry begun, Arithmetic reviewed, French or German.

Shop Work.—Turning, Planing and Drilling Metals; Study of Machinery.

Drawing.—Commence Finished Drawings of Structure or Working Machine, with Full Details.

Spring Term.

Academic Studies.—American and English Literature, Higher Geometry, Geology, French or German.

Shop Work.—Machine Construction.

Drawing.—Complete Drawings of Winter Term.

5. Worcester Polytechnic Institute.

The Worcester County Free Institute of Industrial Science was founded by John Boynton, Esq., of Templeton, in 1865, and its scope and purpose are set forth in the following extract from his letter of gift, dated May 1, 1865:

"Being desirous to devote a portion of the property which, in the good providence of God, has fallen to my lot for the promotion of the welfare and happiness of my fellowmen, I have determined to set apart, and do hereby set apart and give the sum of one hundred thousand dollars, for the endowment and perpetual support of a free school or institute, to be established in the county of Worcester, for the benefit of the youth of that county.

"The aim of this school shall ever be the instruction of youth in those branches of education not usually taught in the public schools which are essential and best adapted to train the young for practical life; and especially that such as are intending to be mechanics or manufactures, or farmers, may attain an understanding of the principles of science applicable to their pursuits, which will qualify them in the best manner for an intelligent and successful prosecution of their business; and that such as intend to devote themselves to any of the branches of mercantile business, shall in like manner be instructed in those parts of learning most serviceable to them; and that such as design to become teachers of common schools, or schools of a like character as our common schools, may be in the best manner fitted for their calling; and the various schemes of study and courses of instruction shall always be in accordance with this fundemental design, so as thereby to meet a want which our public schools have hitherto but inadequately supplied."

This general aim has been steadily kept in view, and others, chiefly residents of the city and county, without whose coöperation the early purpose of the school could not have been realized, have generously supplemented the original gift, and have enabled the school more perfectly to fulfil the intent of its founder.

In 1887, the name was changed to the Worcester Polytechnic Institute.

It is authorized to hold property to the amount of $1,000,000.

The institute offers a good education—based on the mathematics, living language, physical sciences and drawings—and sufficient practical familiarity with some branch of applied science, to secure to its graduates a livelihood. It is specially designed to meet the wants of those who wish to be prepared as mechanics, civil engineers, chemists, or designers, for the duties of their respective profession.

The plan of organization is in the main that of the polytechnic schools of Europe, but with such modifications as are rendered necessary by differing conditions. Special prominence, however, is given to the element of practice which is required in every department.

In favor of this feature of the training adopted at the institute, there may be assigned the following reasons:

1. The fact that some of the most successful and sagacious manufactures and business men, as well as many able educators, continually recur to the idea of combining manual labor with school instruc-

tion, shows the increaing demand for a closer union of theory and practice in technological training.

2. Those who are actively engaged in the practice of engineering, are generally agreed that every young man training for an engineer should acquire familiarity with the practical side of his profession. The acquirement of the manual dexterity, conceded by all to be desirable, may procede, accompany, or follow the technological training. In this school it accompanies that training.

3. Most of the young men who have graduated from the institute have readily found employment in situations for which their technical education particularly prepared them, and have proved themselves well fitted for their work.

But while practice is made thus prominent, it is insisted that it should spring from a clear comprehension of principles. Practice is not an end, but a means and help to the best instruction. With this view of its relation to theoretical work in the school training, the student's entrance on the pursuit he has chosen becomes an expansion of his course of study, rather than an abrupt transition to a new sphere of life.

In acquiring knowledge of any form of handicraft, or of the practical industries by which society is supported and carried on, it is essential that the student should practice under conditions as like as possible to those which he will meet in life. The more his work is subjected to the inexorable tests of trade, and the more he feels the same responsiblity that is inevitable in actual business, the better.

For the acquisition of practical familiarty with different branches of applied science, the same facilities are offered as in the best schools of technology elsewhere—in mechanical engineering, *shop practice* is added to the course and incorporated in it.

Practice, in the school, is subject to three conditions: First, it shall be a necessary part of each week's work; secondly, it shall be judiciously distributed and constantly supervised; and thirdly, the students shall not expect or receive any immediate pecuniary return for it.

At the middle of the first year every student who has not already done so (under the advice of the instructors) chooses some department and until his graduation, devotes ten hours a week and an additional month each year, to practice in that department. Sudents who select chemistry work in the chemical laboratory; the civil engineers at field work or problems in construction; those who select drawing in the drawing room; and those who take physics in the physical laboratory. The mechanical engineers practice in the machine shop from the beginning of the apprentice half year and their practice extends over the whole course of three and a half years.

The charge for tuition is one hundred and fifty dollars per year, and is free to students who *at the time of admission to the institute are*

residents of Worcester county. Twenty students selected by the Board of Education, and who are residents of Massachusetts, but not of Worcester county, may also receive free tuition.

All students are charged an average of eight dollars per year—or three to five dollars per half-year—for use of chemicals and apparatus in the laboratories, and extra for breakage. Students of junior and middle classes who practice in the chemical laboratory are charged thirty dollars per year, and members of the senior class forty dollars per year, exclusive of breakage.

Candidates for admission to the junior class should have attained the age of sixteen years, and must give evidence of proficiency in the common English branches, viz: History of the United States, geography, grammar and arithmetic—in French, plane geometry, and algebra as far as quadratic equations. In general, students at the end of the third year in the high school are prepared for the studies of the institute, though a full high school course is desirable.

Students can enter an advanced class at any time, but only after satisfactory examination in the studies already pursued by that class.

An apprentice class is received at the beginning of the second half-year on the following conditions:

1. Each applicant shall pass the requisite examination for admission to the institute, as stated above.

2. The class will spend thirty-nine hours a week in the shop, six in free-hand drawing and five in recitation, till July 1. The shop work will be in the wood room.

3. In August, following their admission, the members of this class who pass the examination in June will join the regular junior class, and proceed with the course of study as it is laid down in the catalogue.

4. Any student is liable to be dismissed from this class who does not, during the preparatory half-year, evince a decided aptness for mechanics.

All beginners in mechanics must enter the apprentice class.

The capacity of the wood room limits the number in this class to thirty two.

The training of students preparing for mechanical engineers occupies three and one-half years; that of all others three years of *forty-two weeks* each. There are, therefore, four classes, viz: Apprentice, Junior, Middle and Senior. Every student must belong to one of these classes, the capacity of the institute not permitting admission to special or partial courses.

Certain studies are common to all departments, for it is the aim of the school to give as complete a general education as possible, as well as to point out the true relation of theory and practice.

Instruction is given by recitations, lectures and practice, which together constitute a symmetrical course of study. The course closes

with the preparation, by each student, of a thesis or report. Members of the apprentice class, who appear in the junior class, are excused from free-hand drawing for the first half-year, and during senior year the courses for the different departments vary, but otherwise all students attend the recitations and lectures appointed for their respective classes. But the exercises in practice are widely different.

Lectures are given by all the professors on topics suggested by their work, as occasion may demand, and in some departments this form of instruction is, of necessity, chiefly employed. Students are, in all cases, required to take notes and to sustain examination on the lectures

Courses of study and practice are offered in:

1. Mechanical engineering,
2. Civil engineering.
3. Chemistry.
4. Drawing.
5. Physics.

At the middle of the junior year, each student except those in the course of mechanical engineering, chooses a department under the advice of the instructors, and from this time to the end of the course devotes to it his practice time.

Mechanical practice begins in the January preceding the junior year, according to the plan for the apprentice class. Practice in all departments continues to the end of the course.

Thesis.—Each student before graduating is required to prepare and submit to the faculty a satisfactory report of thesis on some subject connected with his special department.

Recitation and practice are assigned to the classes according to the following scheme, the figures indicating the hours per week:

FIRST HALF YEAR.

Seniors.—Theoretical Mechanics or Organic Chemistry, 5. English, 5. Chemistry, 2. Physics, 4. Mechanical Drawing, 6. Practice, 10.

Middlers.—Analytical Geometry, 4. Descriptive Geometry, 3. Physics, 1. German, 4. Chemistry, 2. Free Drawing, 2. Mechanical Drawing, 6. Practice, 10.

Juniors.—Algebra, 3. Geometry, 3. German, 4. Chemistry, 2. Physics, 2. Free Drawing, 6.

SECOND HALF YEAR.

Seniors.—Applied Mechanics or Organic Chemisty, 5. English, 5. Thermo-dynamics or Gas Analysis, 2. Geology, 1. Mechanical Drawing, 6. Practice, 10.

Middlers.—Calculus, 6. German, 4. Physics, 3. Free Drawing, 2. Mechanical Drawing, 6. Chemistry, 3. Practice, 10.

Juniors.—Trigonometry, 2. Algebra, 1. Analytical Geometry, 1. German, 4. Solid Geometry, 2. Chemistry, 4. Physics, 2½. Free Drawing, 6, Practice, 10.

Apprentices.—English or French, 5. Free Drawing, 6. Practice, 39.

Great importance is attached to the study of language for its intrinsic worth and the auxiliary advantage it gives in the pursuit of all other

branches. Throughout the course careful attention is given to the structure of language, as well as to its obvious concrete forms.

All students pursue the study of German two years.

In connection with the recitations in German, and in all exercises special care is bestowed upon the study of the English language, and constant practice in writing it is insisted upon.

In senior year, by means of lectures by the professor, and debates, oral reports, readings, essays, etc., by the students, an attempt is made to cultivate a critical taste for literature and some familiarity with the best models, so as to lay a foundation for a good style of English composition. Also, the principles of civil government and political economy are made sujects of study during a part of this year.

All students are taught free-hand drawing. This embraces carefully planned exercises in outline drawing, shading and coloring from models and casts, special attention being given to drawing from working models, and to sketching directly from nature. This course is of great value in all departments of applied science.

In the mechanical drawing room instruction is given in the use of instruments, shading and coloring, plane and isometic projections, and theory of shades, shadows and perspective; also, in making detailed and finished working drawings of machines from specific data, including the drawings used in the construction of the machine or motor built in the Washburn machine shop by the senior class. All drawing is done under the eye of the instructor.

Students who evince marked aptitude for drawing are admitted to practice in this department.

A course of lessons is devised for each student in practice, preparatory to designing for textile fabrics, lithographing, etc. Students enjoy access to collections of illustrations and examples. Students who practice in drawing join the civil engineers in the study of stereotomy.

The course in drawing is the best preparation for the business of a designer, whether for prints, fresco and ornamental painting, or any other similar art.

The course in mechanical engineering includes instruction in theoretical and applied mechanics, thermo-dynamics and practice.

In theoretical mechanics, the principles of statics and dynamics are taught and illustrated in the solution of a wide range of problems, including in statics the combination of the simple mechanical powers, the determination of center of gravity of surfaces and solids, the effect of friction, the pressure of liquids, and center of pressure of immersed surfaces; and in dynamics, relations of time, space and velocity in uniformly accelerated motion, the altitude, range and time of flight of projectiles, the impact or collision of bodies, the constrained motion of bodies, including the pendulum, the moment of inertia of surfaces and solids, the motion of liquids, etc.

In applied mechanics, problems are solved relating to the strength

and deflection of beams, pillars and girders; the bursting strength of boilers, pipes, and thick hollow cylinders, the torsional strength of axles and shafts, the construction of gears, the designing of link and valve motion for the locomotives, the energy and work of moving bodies, the work of steam in the steam cylinder, the tractive power of the locomotive, the transformation of energy, and many other problems relating to the construction of hydraulic and steam motors and machinery.

Those who desire to begin the course in mechanical engineering *must enter the apprentice class.* A limited number, however, may be admitted to this department *provided* they have had at least one year of actual work in wood or iron in some approved shop In each case a certificate from the proprietor or foreman of the shop is required, setting forth the amount and kind of work which the apprentice has done.

PRACTICES.

Two principles are observed in the arrangement of the practice in this department: First, that while labor with hand tools and machines should be wisely blended, yet since machinery has a constantly increasing share in the conversion of material into useful forms, the educated mechanic should know how to design, construct, and assemble the parts of a machine, as well as how to make its product; and, second, that excellence in construction is to be sought as a most valuable factor in instruction.

The power of the engineer to decide upon general grounds the best form and material for a machine, and to calculate its parts, is vastly increased by blending with it the skill of the craftsman in manipulating the material, and the fact that the product is to be tested and used, kindles interest in its manufacture and furnishes additional incentive to thoroughness and exactness. After the earliest lessons, the practice is on commercial goods, and follows the best methods of commercial production.

For this work unusual facilities are offered at the Washburn shops of the Polytechnic Institute. These shops were founded by the late Hon. Ichabod Washburn, of Worcester, and his purpose concerning them is expressed in the following extract from his letter of gift, dated March 6, 1867:

"There shall be a machine shop of sufficient capacity to employ twenty or more apprentices, with a suitable number of practical teachers and workmen in the shop to instruct such apprentices, and provided with all necessary steam power, engines, tools, apparatus, and machinery of the most improved models and styles in use, to carry on the business of such machine shop in all its parts as a practical working establishment. There shall be a superintendent of such shop, who shall be appointed and subject to be removed by the trustees, who shall be a man of good morals and Christian character, having a good English education, a skilful and experienced mechanic, well informed and capable of teaching others in the various parts and processes of practical mechanism usually applied or made use of in the machine shops

of the country, who shall devote his time and attention to the management and business of the shop, purchasing stock, making contracts for the manufacture and sale of machines, and other work usually done in machine shops, subject to such rules as the trustees may prescribe, and having charge of the proper financial concerns of the shop, hiring necessary workmen, and discharging the same at his discretion, and shall see that the apprentices are suitably taught in all the departments of practical mechanism, working of woods and metals; and use of tools, so as to make them, so far as it may be, skilled workmen, and fitted to carry on business for themselves after they leave the shop, at the expiration of their apprenticeship.

"He shall, moreover, have a care and oversight over the apprentices, such as a faithful master would exercise, to the end that they may cultivate habits of industry, good conduct, and attention to their studies."

Recently the capacity of the shop, as originally built by Mr. Washburn, has been nearly doubled by the gift of $13,600 from David Whitcomb, Esq, and Hon. Stephen Salisbury. The shop buildings, as now enlarged consist of a three-story central structure one hundred feet long by forty feet wide; having two extensions each thirty-five by forty feet, two stories high, and a two story L., seventy-five by twenty-six feet.

The building contains engine room, engine and boilers; blacksmith shop, tool room, draughting room, painting and finishing room, and large work rooms for both wood and metals, fully equipped with tools and machinery. Here the students in mechanical engineering spend their practice hours as apprentices, and it is found that the graduates in this department are as skilful mechanics as ordinary apprentices who have served three years in a shop, and they have in addition the advantages of a solid education. This result is attained under the following conditions:

1. These shops are organized and managed as a manufacturing establishment, and a great variety of work is always in process of construction in order that the students may constantly have the wholesome atmosphere of real business. This, with a determination on the part of the superintendent to maintain a high standard of workmanship, has made the progress of the students in the best methods of construction both rapid and thorough, and has proved the most effective means of giving them an exact knowledge of shop practice. The jurors at the Centennial Exposition decreed an award to the shop for its tools for working metals which were exhibited in Machinery Hall, and first premiums have been awarded wherever these tools have been exhibited.

2. The work of each student is done under the personal supervision and direction of a skilled workman, and with the advantage of the best obtainable tools and machinery; for it is as true in handicraft as in the training of the intellect, that the best tools and appliances are not too good for instruction.

3. Every student receives training in drawing during the entire course. In this way exact knowledge of form and proportion is secured, and the students make more intelligent and satisfactory

progress in the shop, than is possible for those who have not had the advantage of this training. Beside the general training in free-hand and instrumental drawing, students in this department have practice during senior year in making working-drawings of machines, and in determining the strength, dimensions, and proper proportions of machines from numerical specifications.

4. The weekly practice is distributed so as to occupy five hours of each of two days. Each student is required to render a strict account of these hours. The time thus spent serves the double purpose of practice and of exercise.

5. Each student advances as fast as possible, unchecked by the difficulties of his neighbor, or any business necessity of the shop.

To these advantages, viz., the service of construction in the work of instruction, the discipline and culture of free-hand drawing, careful distribution of time, and relief from all unnecessary detail, should be added the consideration which far outweighs them all, that students come to their work with the perceptive faculties, the reason, the judgment and the taste all under constant and careful training in school. Theory and practice accompany and supplement each other. Under these conditions, it is clear that the students must during their practice have direction and efficient instruction. To provide for this, Hon. Ichabod Washburn also gave a fund of $50,000, the income of which may be applied towards paying the running expenses of the shop, with the expectation that twenty young men would receive its benefits. With the present facilities, over one hundred are accommodated.

In general the apprentice class are taught the use of wood-working tools and machinery; the junior, middle and senior classes work mainly on iron.

Practice in the machine shop and draughting rooms comprises:

IN THE WOOD ROOM.

Bench Work.—This includes a great variety of manipulation, under constan instruction in laying out work with the knife and pencil, the use of planes, the hand-saws, chisels, gouges, squares, gauges, and other tools.

Wood Turning.—With the use of the various turning tools, on hard and soft wood.

Machine Sawing.—With large and small circular saws, and scroll saws.

Machine Planing.—With the cylinder and Daniels planer, machine boring, the use of the shaping and molding machines, and the auxiliary manipulations of all the machinery used.

IN THE IRON ROOM.

Bench Work.—Filing and chipping, preparing work for lathes, tapping, reaming, scraping and fitting plane surfaces, finishing with oil-stone and emery cloth.

Work with Speed Lathe.—Drilling and countersinking, filing and polishing, hand-tooling.

Work with Engine Lathe.—Instruction in the use and care of lathe and turning tools, squaring up, the proper and maximum speed for cutting metals, turning to exact size, the use of the calipers, a variety of turning, both heavy and light; cutting threads, squaring up and finishing nuts, chucking straight holes, reaming, inside boring, boring with boring-bar, fitting bearings, etc.

Drilling.—With speed-lathe, upright and traverse drillers.

Milling.—Use of the universal milling machine—milling nuts, bolt heads and studs, cutting splines, fluting taps and reamers, milling to size and line. cutting gears.

Planing.—Instruction in the use of the planer, planing surfaces and bevels.

Work with Screw Machine.—Making machine bolts with revolving head screw machine, cutting up stock, making screws and studs, and tapping nuts.

Tool Makiug.—The correct forms of turning tools, and the principles of grinding them; making taps, dies, reamers, twist-drills, countersinks, counter bores, mills, milling-machine cutters, mandrels, boring-bars, chuck-drills, centers.

Management of Steam.—Care of the boilers and engine, including the work of firing; the care and control of the steam pressure and water supply; also the care and manipulation of the steam pump and injectors. The practice in the steam department is under the constant oversight of the engineer.

Designing and Constructing.—In senior year after the students have each accomplished the practice just specified, they build one or more complete machines from their own drawings. These drawings, though made from definite specifications, are intended to afford ample field and scope for the personal responsibility and originality of each student, in making correct design and arrangement of the parts of the machine in hand. While this work is not copying, it must not depart essentially from the best practice among manufacturing mechanics. Previous classes have constructed a twenty-five H. P. Corliss engine, a ten H. P. upright-reversible engine, a forty H. P. Buckeye engine, a thirty H. P. high speed straight-line engine; the class of 1885, an engine lathe, eighteen feet in length and having twent-six inches swing; the class of 1886, a Hendy shaper, and the class of 1888 will complete a No. 1 cabinet turret lathe with seven foot bed, twenty inch swing, and with engine feed, back gears, screw apparatus and overhead works.

"While we depend mainly upon real work, with machines and tools in the hands of the students to give him practical knowledge and experience, we also desire to make the instruction as broad and general as possible.

"For this purpose a beginning has been made for a permanent exhibit of the best American and foreign tools of all kinds, properly arranged and open to the inspection of the students, and used as an illustration of the best, so that the student may become familiar with standard tools and the names of the makers.

"This exhibit of tools and machines is used in lectures and general instruction to classes.

"The practical value of the work after graduation is indicated from the fact that ninety per cent. of the gradnates are now working successfully in the professions for which they were trained."

XII. MINNESOTA.

1. Minneapolis Public Schools.

Dr. J. E. Bradley, superintendent of public schools, Minneapolis. Minn., forwards the following account of the work in that city, prepared under date of October 8th, 1888, by Mr. W. F. Decker, superintendent of manual training:

"There are 148 pupils enrolled at the present time at the Central high school and at the two branch high schools where the work was commenced at the beginning of the present term. At the Central school we have benches and tools to accommodate 34 at one time or 102 during each morning session of four hours, each pupil working during two recitation periods or 80 minutes each day at the bench.

"So far wood-working and industrial drawing only have been attempted. Each bench in the wood-working shop is provided with saws, hammers, planes, try-squares, T bevels, wing-dividers, gouges, chisels, bits and other tools that are in general use in wood working trades. These tools all have places on the tool racks and are marked to correspond with the number of the bench to prevent their being misplaced. Each bench is 14 feet long and provided with two carpenter's vises and six drawers with locks. Two pupils work at one time at each bench and each one has a drawer for his unfinished work which he locks at the close of each exercise. Each pupil is also required to leave the tools he has used in their proper places, and dust off the bench in order that it may be ready for the next section.

"It will be seen that by our system the tools on each bench are used in common by the pupils of three sections, but that each pupil, who has his regular place, uses the same tools each day.

"Instruction is given in the following way :—The class is assembled at the commencement of each exercise and the lesson explained from a large working drawing on which are marked all dimensions sufficiently plain to be read by members of the class seated before the instructor. Each step of the lesson is carefully pointed out and difficult operations are performed by the instructor before the class. Questions are answered concerning the lesson and an effort is made to have each member of the class clearly understand the whole operation before going to his place at the bench. After giving a signal for pupils to take their places at the benches, the instructor employs the remaining time in giving individual instruction at the benches and in inspecting the work. The lessons commence with such simple operations as sawing, nailing, planing, paring, etc , and include seventeen exercises in making simple joints, and during the latter part of the first year

pupils construct such articles as small panel doors, models of door-steps, models of roof trusses, cases of drawers, etc. During the second year some quite different lessons are given in working hard woods. The first year lessons are all in working pine.

"Experience has shown that too much attention cannot be given to the first elementary eperations. If pupils do not get a good drill in these all of their work will be bad, and where the proper amount of drill is given in the elements, rapid and substantial progress is made. I think in many manual training schools sufficient attention is not given to the elements and pupils are allowed to construct things too early in the course before they have mastered the use of tools. The same rule applies here as in all branches of education—*the elements must be thoroughly taught first.* During the latter part of the course in wood, working pupils will work largely from their own drawings. Each pupil works half as much time in the industrial drawing room as at the bench during the course.

"Though we have worked but little over one year and commenced in a very small way, the work already done has been highly spoken of by mechanics and educators, and the pupils generally take great interest in the work without losing interest in their other studies.

"The equipment of the branch high schools is precisely the same as at the central school, though accommodations are not furnished for so large a number."

In his letter of transmittal Superintendent Bradley adds the following brief statement:

"The plan has been in successful operation in our central high school since January, 1887. This year the work has been extended to our branch high schools. Thus far we have confined the exercises to wood work but we shall soon be ready to take up metal work, and expect to have a course extending over the four years' course. We are just now introducing sewing into the fourth grade year in all our schools and hope in due time to extend it to the grades above and below. We are also doing considerable in the way of modeling and kindergarten work.

"We have few precedents to guide us and my aim has been to incorporate the training of the hand and the eye into our regular school work by gradual introduction and natural growth rather than by violent re-adjustments. We are doing a good deal of good work in various departments of drawing."

2. The University of Minnesota.

The University of Minnesota is one of the institutions founded in accordance with the act of Congress of July 2, 1862.

The college of mechanic arts in the university embraces four regular courses of study, viz: civil engineering, mechanical engineering, electrical engineering and architecture.

The aim of the instruction given in the regular undergraduate courses of this college is to lay a broad and solid foundation in mathematics, mechanics, electricity and drawing, so that with the practice in field, shop, office and laboratory work given to the students in the respective courses they shall be fitted for immediate usefulness upon graduation, and after a moderate amount of subsequent practice and experience, be capable of taking charge of important work.

ADMISSION.

The courses of this college are open, free of all charges for instruction, to all persons over fourteen years of age, whether residents of the State or not, who may pass the required examinations. Applicants will not, however, be admitted to the preparatory class (subfreshmen) provided they can get instruction in the subjects taught in this class in the school district in which they live.

Applicants for admission to the sub-freshman class will be examined in the following studies: Latin grammar, English grammar, English composition, arithmetic, elementary algebra, history of Greece and Rome, history of the United States, physiology. Those who do not intend to pursue Latin will be examined in Cæsar and Cicero, or, in lien thereof: physical geography, history of England.

Applicants for admission to the freshman class will be further examined in the work of the sub-freshman year, in the course chosen. The mechanical engineering course in detail is as follows:

SUB-FRESHMAN YEAR.

FIRST TERM.	SECOND TERM.	THIRD TERM.
Botany [2]. Chemistry [3]. Higher Algebra [2.] Drawing, Mechanical [3], 6 hours. English, or German, or Latin.	Drawing, Free-hand, 6 hrs; Mechanical, 4 hours. Plane Geometry [5]. English, or German or Latin.	Chemistry [2]. Botany [3]. Solid Geometry [5]. English, or German, or Latin.

FRESHMAN YEAR.

FIRST TERM.	SECOND TERM.	THIRD TERM,
Drawing, 10 hours [5]. Higher Algebra. English, or German, or Latin.	Chemistry [5]. Logarithms and Trigonometry. English, or German, or Latin [5].	Drawing, Perspective [5] 10 hours. Botany [5]. English [5]. Surveying [2].

SOPHOMORE YEAR.

FIRST TERM.	SECOND TERM.	THIRD TERM.
Analytical Geometry [4]. Physics [4]. English, or French, or Latin [4]. Carpentry [5].	Differential Calculus [4]. Physics [4]. English or French [4]. Pattern Work [5].	Integral Calculus [4]. Elements of Mechanism [4]. English, or French, or Latin [4]. Foundry Work and Drawing [5].

JUNIOR YEAR.

FIRST TERM.	SECOND TERM.	THIRD TERM.
Kinematics [5]. Descriptive Geometry [5]. Any Junior first term elective [4]. Forge Work [5].	Mechanics [5]. Hydraulics, etc. [5]. Mineralogy [4]. Vise and Machine Work [5].	Mechanics [5]. Testing Materials [5]. Any Junior third term elective [4]. Machine Work [5].

SENIOR YEAR.

FIRST TERM.	SECOND TERM.	THIRD TERM.
Applied Descriptive Geometry [5]. Geology or Astronomy [4]. Machinery [5]. Machine Details [5].	Steam Engines and Motors [5]. Experimental Mechanics [5]. Any Senior second term elective [4]. Steam Engine Details [5].	Designs, Specifications, etc. [5]. Machine Tools and Thesis [5]. Any Senior third term elective [4]. Drawing on Designs [5].

In this course shop-practice and work in experimental mechanics take the place of the field work in the civil engineering course. The shop-work covers two years' time, and it is the intention to give the student such a drill as shall enable him to design machinery with a view to simplicity of construction, and to superintend its construction.

In the testing laboratory the same drill in testing materials is given as to the civil engineering students, while in addition, accurate and complete tests of belting, cutting power of tools, lubricants, engines, boilders, pumps, etc., are made, thus preparing the student for expert work as well as impressing by actual experiment the principles of the text-books. Carefully kept records are required in every case and tha results of each experiment are worked up in the most approved manner.

In the class room after the drill in mechanics and the strength of materials referred to, courses are given in hydraulics, machine design, the steam engines, and other motors, beside courses previously given in mechanism and kinematics.

In the drawing-rooms working and finished drawings are made of various machines as well as tracings and blue prints of the same, care being taken to follow as far as possible the methods of the best machine shops.

During the last term of the course original designs and specifications of machinery, engines, boilers, etc., are made and a thesis prepared, which, with the necessary drawings, is a condition of graduation.

In all the regular courses in this college, instruction is given by means of text books, lectures, reading in the library, practical problems, and a large amount of work in the drawing rooms, laboratories, shops and in the field. It is the aim to lay a solid foundation of principles, which, with the large amount of practical work we are able to give, will fit the graduate for immediate usefulness among engineers. In all the work the strictest accuracy is insisted upon.

The equipment of this department comprises:

The engine and boiler room, 20x24 feet, is provided with an automatic cut-off engine, of modern type, capable of developing thirty-five horse power. A steel boiler of ample size furnished with a feed pump and heater supplies steam. A dynamometer, friction brake, calorimeter, pyrometer, revolution counter, tanks, steam-engine indicators, gauges, thermometers, and other instruments required for complete steam-engine and boiler tests, are provided for the use of students in experimental work.

In this room is also a hundred-light Edison dynamo, with amperemeter, regulator and pressure indicator.

The Machine Shop.—The machine and vise shop, 25x50 feet, contains one speed lathe, ten engine lathes of various sizes, a planer, shaper, universal milling machine, vertical drill press, emery tool grinder, grinding attachment to lathe, benches with ten vises. surface plates, a set of Betts' standard gauges, taps, dies, reamers, drills, chucks and other hand tools and accessories for practice in machine, tool and vise work.

The Wood-Working Shop.—The shop for patternmaking and general wood work, 24x48 feet, contains benches with ten vises, ten lathes, ten sets of hand and lathe tools, two circular saws, a jig saw, band saw, planer, boring machine, grindstone and other tools for use in the courses of carpentry and patternmaking.

The Forge Shop.—The forge shop, thirty-one feet square, is provided with a portable hand forge, ten stationary forges with anvils and sets of tools, a blower, exhaust fan, hand drill press, drills, taps, dies, sledges, swages, a grindstone and the other tools generally used in blacksmithing.

The Foundry.—The foundry, 20x30 feet, contains an 18-inch cupola, brass furnace, core oven, cinder mill, molding tools and benches, core plates, arbors, sweeps, ladles, crucibles, and all of the tools and

material ordinarily needed in molding and casting iron, brass or white metal.

There is also a room, 24x46 feet, fitted up for a testing laboratory. It is supplied with power, and contains a 50,000 pounds testing machine, which can be adapted for compressive, tensile, transverse, torsion and shearing tests. Other pieces of apparatus have been designed by the department to be used in connection with the testing machine in making tests of full-sized beams, up to twenty-five feet in length. An instrument purchased for use in connection with tensile tests, is capable of actually measuring extension to one ten-thousandth of an inch. There is also a cement tester, a dynamometer for measuring transmitted power, an oil testing machine, standard scales, and other apparatus for mechanical tests. There is now under construction in the machine shops, a dynamometer for determining the power of lathe tools, and a ten-horse power steam engine which will be used for experimental purposes.

Each shop will accommodate ten students at a time, which is as large a number as can be advantageously instructed together. The capacity of the shops can be increased to meet any probable requirements by forming additional classes.

The instruction given is based on the "Russian System," in which the leading idea is to teach principles rather than to produce objects of commercial value. It is believed that the greatest progress can be made in a given time with this method, as the student proceeds, by a carefully-planned series of exercises, from the simplest to the most difficult operations, learning the processes but avoiding the repetition of the ordinary shop. So far as is consistent with this system, the work is adapted to parts of some machine or structure in common use. and, after finishing the exercises referred to above, the class will build some complete machine or structure, as a review and application of the preceding work.

Besides the four regular courses mentioned above, the work of this school is classified as follows:

A. A two years' course in shop work, drawing and mathematics, for young men who wish to fit themselves for positions of trust in shops and factories.

B. A one year's course in the care and management of engines and boilers, intended as a preparation for the examination of the State inspectors.

C. A course in shop work and drawing for those whose time or lack of fitness prevents them from entering division A.

D. A course in industrial drawing alone for those who wish to devote their whole time to this work.

A DIVISION—FIRST YEAR.

FIRST TERM.	SECOND TERM.	THIRD TERM.
Carpentry. Drawing. Elementary Algebra [3]. Free-Hand Drawing [2].	Patternmaking. Drawing. Algebra. Geometry.	Foundry Work. Drawing. Geometry.

SECOND YEAR.

FIRST TERM.	SECOND TERM.	THIRD TERM.
Forge Work. Trigonometry. Drawing (Machine Details).	Vise and Machine Work. Mechanics. Drawing (Machine Details).	Machine Work. Mechanism. Drawing (Designing.)

B DIVISION.

FIRST TERM.	SECOND TERM.	THIRD TERM.
Recitations and Lectures on Care of Engines and Boilers. Drawing. Engine Running.	Principles of Engines and Boilers. Vise and Machine Work. Engine Running.	Indicators and Engine Tests. Drawing (Engines and Boilers.) Engine Running.

C DIVISION.

Shop Work and Drawing.

D DIVISION.

Industrial Drawing.

Applicants for admission to any of the divisions must be at least fifteen years of age, and must pass examination as follows: A and B divisions, in arithmetic and writing; C and D divisions, no examination required.

Members of A division who can pass in any of the mathematics or other work of the course, and who pass examinations in geography and United States history, may be allowed to substitute, for the subjects passed, studies from the other courses, under direction of the faculty. Members of divisions A and B who satisfactorily complete the courses as laid down, may receive certificates of having done so, signed by the president of the university and the director of this college.

Members of all divisions are required to deposit $5 with the registrar of the university, which will be returned when connection with the school ceases, less such charges as may be made for material furnished and damage to any university property. Members of divisions A, B

and C are required, each term, to deposit $5 with the director of the college, which will be returned at the close of each term less such charges as may be made for material used in shop work, which is not made into apparatus of value to the college.

METHODS OF INSTRUCTION.

"In the courses of the Artisans' Training School the instruction in shop work is given by means of carefully prepared exercises. These exercises are planned wholly with the object of instructing the student in the use of tools, leaving out the idea of construction, except in so far as it may not interfere with instruction. The function of this school being to teach the use of tools in general, rather than any particular trade, much time can be saved by devoting the entire attention of both student and instructor to the manipulation of the tools, and avoiding the repetition of the same operation, which necessarily occurs when construction is an object rather than an incidental. The preparation of exercises, in any particular branch of work, consists in first carefully analyzing the various operations and reducing them to their simplest forms, and then classifying them in such a way as to have them succeed each other in the order of their difficulty. Thus, if we examine into the work usually done at the vise, we see that the greater part of the work done there is made up of various combinations of the following operations: Filing to straight or curved lines, either between two lines or to one line alone, filing to template, fitting, free-hand filing, with and without the hand vise, sawing and chipping plane and curved surfaces. Starting, then, with these operations to be taught, a course is designed which shall take them up, one at a time, and apply them to wrought iron, cast iron, and steel. The other courses are on the same general plan as that outlined for vise work.

"The drawing in this school is conducted on the same plan as in the engineering courses, the students first using the text-book prepared for the department, and afterwards varying their work to meet their individual requirements."

"In mathematics the instruction covers algebra, plane and solid geometry, and trigonometry, taught with special reference to the needs of this class of students, and giving many applications to practical matters, while the instruction in mechanics and mechanism is made as clear of higher mathematics as the subjects will allow.

"The instruction in the course in the care and management of engines and boilers is given by means of practice in the engine room, under the immediate direction of the engineer. By means of lectures and recitations the reasons for the regulations, as laid down for running, are explained, and the principles of the steam engine and of the construction of boilers is given in a manner not difficult for one of ordinary intelligence to understand; and finally, instruction and practice in the use of indicators, and in the various tests of engines and boil-

ers is given. It is believed that this course will fill a need which has long existed, and will help to supply engineers who are competent and trustworthy."

3. St. Paul Public Schools.

The following extract from the last annual report of the city superintendent gives an excellent statement of the considerations which led to the adoption of the system in that city, and the spirit of admirable caution in which the whole movement has been conducted.

"MANUAL TRAINING."

"Manual training in the public schools is attracting to a large degree the attention of many of the best and most thoughtful people throughout the country. Experiment and discussion have developed a strong public sentiment in favor of giving manual training a prominent place in the plan of public education, but not with the desire of displacing much, if anything, of the ordinary subjects of study to give it room. The great value of manual training is being rapidly demonstrated in some of the largest cities of the country, notably St. Louis, Philadelphia, Boston and New Haven. The advantages claimed to result from the combination of mental and manual training, or instruction, seem to have given a new impulse toward the establishment of like schools in several cities of the country.

"The work done in the manual training school established in this city at the beginning of the school year, [October, 1887,] was very commendable. During the year both sexes were allowed to engage in the work of the school. The course included lessons upon the use of the splitting and cutting-off saws, the different bench planes; the making, testing and use of the miter box; common and blind dovetailing, mortises and tenons, key tenons, etc.

"One question which meets us on engaging in this work is, how to find the time for it? In some cities the pupils are taken in school hours from the regular schools by delegations, and sent to the building where this class of education is carried on. Such a plan has serious objections, because it must of necessity cause an interruption of the regular studies.

"Such schools are largely experimental. What is needed then it seems, is not experiment but the broad reality. These new lessons it seems to me, should be given in harmony with some existing course. With this end in view, a course of study has been arranged by a committee of the board of education appointed for that purpose, laying out the work for a three years' course. As the benefits of this school could be obtained by only those who had entered the high school, it was thought wise to include in it those pupils in the eighth grade of the district schools who might desire to take the course prescribed, instead of continuing in the grammar schools. The course of study was accordingly arranged and fitted to pupils of this class and age.

"It seems to me that neither teachers, parents nor pupils should get the impression that there is or should be the least rivalry between the lessons from text books and those from things. There may be cases where the unambitious pupils may think that this course of study promises less work and equal improvement and gain. That such will not be found to be the case is most certain. Anything like conflict between the new school and its methods and the old, must result in injury to both. Let each be given a dignified place of its own during the school day, each have its patronage, and the pupils of each have a keen relish for the work as provided, and the success of each, I believe, is abundantly assured.

"As this school will probably be opened when the addition to the high school is completed, the number of those attending the three highest classes in the district schools, who desire to attend this school, was ascertained through the principals of the different grammar schools of the city. Cards were sent to the parents of these pupils, and it was found that nearly eighty were returned, giving the sanction of the parents to the statement that their sons might enter on the course prescribed for this school.

"The work of the past year, while not entirely experimental, was carried on somewhat for the purpose of ascertaining the feeling in the community in regard to the establishment of such a school.

"During the past year both sexes were allowed the privileges of the school. It was however, deemed advisable to restrict the enrolment in the school to boys only, as the plan of work adopted would in the main preclude the enrolment of girls in the school. We believe the plan adopted by the board of education will do much to aid in removing the prejudice which may exist in the minds of some against such a department of instruction, since the aim of the school will be, not so much to teach trades as to prepare pupils for a greater proficiency in trades, should they conclude to become mechanics. To teach boys the use of tools, and to instruct them that the eye and the hand may work together, is greatly increasing their equipment for the practical duties and work of life."

The early history of the work is freely given in the following report of the superintendent of manual training:

THE BEGINNING.

About the 1st of last October [1887] a room in the basement of the high school building had been fitted up with benches, tools and other necessary appliances to accommodate forty-eight pupils in wood work. On canvassing the high school it was found that about twice that number wished to avail themselves of the practice in this department, so that accommodations were immediately made for ninety-six pupils. Eight classes of twelve each were formed—five of boys and three of girls. The pupils took hold of the work with much enthusi-

asm and in most cases the interest still continues unabated. The work in this department at present does not take the place of or encroach upon the time of any other department but is really extra work which is done during the hours usually devoted to recreation. Only two of the classes practice during the regular school hours, the other six reporting in the afternoon from 1:30 to 4:30. The boys' classes each have two lessons of one and one half hours each and the girls one lesson, of same duration, per week. Manual training is optional, but after a pupil has chosen it he cannot leave off without presenting a note from his parents.

THE COURSE OF STUDY.

The following is a synopsis of the course being pursued:

I. Exercises in methods of holding and using,	try-square, gauge, dividers, bevel, saw, mallet, chisel, plane.	
II. Elementary frame work in pine from blue prints made by the instructor,	cross lap joint, tenon and mortise joint, end T & M frame, blind T & M brace frame.	
III. Lathe work,	cylinders, spindles, handles, rosettes, etc.	
IV. Advanced frame work in various kinds of wood, from drawings made by the pupils,	miter lap joint, dovetail joint, lap dovetail joint, methods of scarfing, keyed joints, double dovetail puzzle, etc.	
V. Small articles, embracing,	frame work, nail driving, turning, jig-sawing, etc.,	boot black's box, cannon on trucks, wind-mill, etc.
VI. Cabinet work in hard wood, embracing,	sawing, turning, framing, carving, paneling, etc.,	brackets, foot-rests, wall pockets, etc.

Each boy is required to do every piece of Nos. I, II and III. In Nos. IV, V and VI the pupils do not all do the same kind of work but are given work which will suit their individual ability and taste to some extent. During the course the pupils take turns at the drafting board where they make working drawings from sketches previously brought in of objects to be afterwards worked out in wood. This work is by no means intended to take the place of the work in the drawing room but is intended to supplement it with work developing certain functions of the mind and teaching certain practical

methods which that cannot do. A pupil is asked to make a sketch of his most approved pattern of a box on which to black his boots. This sets him to thinking. After he has the idea it often puzzles him to put it on paper in good form. After an intelligible sketch he makes a working drawing to scale and later the object in wood. He takes pride in the box because it is his own design and he will put his best work into it.

From time to time during the course talks, illustrated as far as possible, are given on subjects connected with or suggested by the work, *e. g.*, uses of and methods of obtaining shellac, glue, turpentine, rosin, etc., also history of saws, a glance at methods of obtaining and common properties of iron and steel, etc.

The course for the girls is made up of No. I, of the above with the exception of the use of the plane, a lesson in nail driving, modelling of simple ornamental forms in clay and carving the same in wood. Each pupil is given the opportunity of selecting some object to ornament with wood carving. If approved by the instructor, the pupil is permitted to make working drawing and clay model of the ornamental parts and then carve the same in wood.

WORK ALREADY ACCOMPLISHED.

The pupils have all finished No. I, of the above synopsis, having made over two hundred pieces. The boys are well along in No. II, having completed about one hundred and sixty pieces already. They have also begun No. III. Besides No. I, the girls have had the exercise in nail driving (about seventy pieces) and several are now modelling in clay. About fifty drawings and sketches have been handed in.

THE FUTURE WORK.

No definite plans have yet been made for next year's work in this department. The subject is under careful consideration by the manual training committee and some definite plan is hoped for soon. The proposed three years' course for boys comprising English, mathematics, science, drawing and manual training is now being laid out; also, an estimate of the cost of the necessary equipment is being made. The manual training in such a course would occupy the pupil two hours per day and would include both wood and iron work. The endeavor, I think, should be to graduate boys with as thorough a knowledge of the branches taken up as boys have who are graduated at any manual training school in the country, but at first it might not be practicable to take so many branches of the work, *e. g.*, it would not be possible to do any extended forge or foundry work in the high school building; but we could have a very thorough and practical course in wood and machine tool work which are the most important. The drawing for the pupils in this course should be carried beyond the present high

school course and should be under the direction of the superintendents of manual training. Pupils taking any other course in the high school should also have an opportunity, as they do now, to take manual training as an extra study twice per week. The course for these would necessarily be much more limited than for those taking the regular manual training school course, but would give them much training and practical knowledge.

Quoting from "A Plea for the training of the Hand," by President Gilman, of John Hopkins University, "the value of manual training as a method of improving the brain and nervous system, or, in other words, our thinking apparatus, must be acknowledged. * * * The importance of carrying forward manual training simultaneously with all other educational processes must not be lost sight of, so that the brain shall be taught simultaneously by the eye through the printed page and through every variety of object lesson, by the hand in measuring, matching, marking and making. * * * * Manual training is an essential part of a good education, whether that education be restricted to the common school or carried on to the highest discipline of technical schools and universities." Coupling the above quotation with the fact that many of our public school pupils leave school before they are sufficiently advanced to enter the high school, and at the same time remembering that these would be greatly aided in gaining a livelihood by having even a limited course of manual training, I think we cannot fail to see the importance of placing manual training within the reach of grammar as well as high school pupils. In the primary grades we have drawing and applied kindergarten work, and in the grammar grades drawing; but, quoting again from President Gilman on this subject, "Something more than drawing is needed, fundamental as drawing is." Give the boys an opportunity to take a course in wood work, and the girls a chance to learn plain sewing. Judging from the experience of others, they can take this manual training three or four hours per week and yet not neglect in the least their other studies.

(Signed) CHARLES A. BENNETT.

ST. PAUL, MINN., *January 25, 1888.*

The following letter from Mr. Bennett continues the record, with some additional observations:

ST. PAUL, MINN., *October 10, 1888.*

"Last year $500 was appropriated to fit up a small shop. This year $2,000 has been appropriated to equip shops for the new school. We are located in the high school building, but our school is entirely separate from the high school in other respects this year. Just now we are working under many disadvantages, being obliged to have our school in the afternoon in the rooms where the high school pupils

were in the forenoon. In about a month, when the new addition to the building is completed, we shall have six good rooms. This year we shall not have metal work, but we have a large room which we hope to fit up for that purpose next year. At present we are having the machinery for wood work put in place.

"Regarding the attitude of the public toward the matter, I think I can safely state that we have the hearty support of every one that knows the scope of our work and of many who do not. Although the press has done its part, it is true that many are still ignorant of the real object of our school. We are aware that our school differs from those of some of our western sisters and eastern cousins, but we have studied the matter quite carefully and at last have taken a decided step. Many of the ideas expressed in our reports of one year ago are not our ideas to-day, as you will see by the course of study adopted."

COURSE OF STUDY—(*For Boys Only*).

In high school building pupils are received from all parts of the city from eighth grade.

COURSE OF STUDY.

FIRST YEAR.

First Term.—Arithmetic, United States History, English Grammar, Drawing one hour per day, Shop Work two hours per day.

Second Term.—Arithmetic, United States History, English Grammar, Drawing one hour per day, Shop Work two hours per day.

SECOND YEAR.

First Term.—Algebra, English Composition or Latin, Physiology, Drawing one hour per day, Shop Work two hours per day.

Second Term.—Algebra, English Composition or Latin, Physical Geography, Drawing one hour per day, Shop Work two hours per day.

THIRD YEAR.

First Term.—Geometry, History or Latin, Physics, Book-keeping, Drawing one hour per day, Shop Work two hours per day.

Second Term.—Geometry, History or Latin, Physics, Book-keeping, Drawing one hour per day, Shop Work two hours per day.

Latin is an optional study in the course, to meet the requirements of technological schools which many of our graduates would seek to enter. The following is an outline of the work in drawing and shop work for the three years covered by the foregoing course of study:

DRAWING AND SHOP WORK.

FIRST YEAR.

Drawing, Free-hand.—3 periods per week:

(a) Brief review of elementary work in straight and curved lines.

(b) Projection (orthographic) and practical sketching of work done in shop, giving dimensions.

(c) Design, principles of, with work especially adapted to wood carving.

Mechanical.—2 periods per week:

(a) Use of instruments; geometrical problems with applications.

(b) Working drawings of exercises in shop, etc.

Shop Work.—In carpenter shop, proper care and use of tools; carpentry, joining, wood carving.

SECOND YEAR.

Drawing, Free-hand.—2 periods per week:
(a) Principles of perspective.
(b) Object and model drawing.
(c) Shading.

Mechanical.—3 hours per week:
(a) Developments and sections.
(b) Orthographic and isometric projections and shadows.
(c) Elements of machine construction.

Shop Work.—In pattern shop, wood turning, pattermaking, care and use of such wood-working machinery as lathe, planer, circular saw, jig saw, band saw, molding and casting in soft metal.

THIRD YEAR.

Drawing, Free-hand.—1 period (or hour) per week:
(a) Pen and ink or pencil sketches of machinery.

Mechanical.—4 periods per week:
(a) Machine construction.
(b) Elementary machine design.
(c) Elementary building construction.

Shop Work.—In the machine room, chipping, filing, drilling, turning, milling, fitting, setting up, care and management of steam engines and boilers.

This account of the school may be properly supplemented by the following report from the Committee on Manual Training, presented to the Board of Education of St. Paul, Minnesota, on February 6, 1888, and adopted by the Board:

"This report does not assume to be a dogmatic answer to the many difficult questions which attend the introduction of manual training into courses of study for public schools—indeed the various and conflicting opinions of members of the committee limit the extent of the common ground upon which they could agree. Its design is to direct public attention to what the board purposes to do in this department in the future, and to elicit public discussion from which good may come.

"In the beginning it is assumed that there is entire unanimity as to the desirability of making the instruction of the schools practical, and that there is a strong public sentiment in favor of manual training as a part of the course of study, although differences of opinion may exist as to the best means for coördinating the new with the old and traditional training now in vogue. The thought for some time seems to have been prevalent that our schools have too much to do with words and the memorizing of symbols, and too little to do with things; that the education of our youth should include a training to express thought by the labor of the hand as well as to express it by language. Coinciding in these views, the committee gave little thought to the question of the desirability of giving our pupils an opportunity for manual training—indeed, the work already in progress had decided that question for our city—but passed at once to the consideration of the best means to accomplish the end decided to be desirable.

"We find that at present a room in the basement of the high school has been fitted up with benches, tools, and necessary appliances to

accommodate pupils in wood work. That pupils of the high school—five classes of boys and three of girls, numbering twelve pupils each—are admitted, the boys taking two lessons of one and one-half hours each, and the girls one lesson of the same duration per week. The committee were unanimously of the opinion that two mistakes had been made in the experiment commenced last September. One in attaching it to the high schools as a department where, before, courses of study were full, and thus making work here additional to that which, in the judgment of some, was already too heavy. Manual training, if introduced properly into our schools, must take the place of something less important and practical. One or two lessons per week in shop work, taken by pupils who are already pursuing an exacting course of study, will scarcely meet the end proposed by the friends of the new education. As now in operation, the manual experiment has little opportunity for future development or increased usefulness.

"It seemed, too, that the appropriate training for the girls was in the line of household duties, the art of cooking and the use of woman's 'universal implement,' the needle, rather than the tools of the carpenter's bench.

"As to the ultimate future of the movement which is finding expression in many manual experiments in the school systems of our larger cities, it is believed that courses of study will be modified, that much that is unnatural will give place to rational training. Primary schools will train children to observe and express their notions in clay and with the pencil, as well as abstractedly in language. This will be the manual training of the primary grades. In schools between the primary and the high school there will be less drill in the technicalities of grammar, less memorizing of the details of geography, less puzzling over abstractions and more teaching which shall bring pupils into contact with material things and forces, and which shall give them ability not only to express thought by language, but by the graphic and creative work of the hand. This will be the manual training of these intermediate grades. Then would come the manual training school, which would admit pupils from the eighth or even a lower grade if experience should show it to be desirable, but at least at an age when they could profitably take up the work of the school. In this school pupils who desire to advance on this line rather than to enter the high school, would take a three years' course of study, including the studies of English, mathematics and science, with two hours' shop work per day and one hour instruction in drawing.

"The foregoing is an outline of what, in the judgment of the writer of this report, should ultimately grow out of our experiment in manual training for the benefit of the boys, although upon all points the members of the committee were not in accord. It is not a scheme which would turn our public schools into trade schools. It would not revolutionize our school system. It does not establish a work-shop in each

school building, but economically gathers from all the schools those of a proper advancement who desire to complete the course in one school where mental and manual training go on together. It answers those who ask: Should not manual training be a part of a good education, whether that education be restricted to the common school, or carried to the highest discipline of technical schools and universities? by pointing to the manual work in drawing, and applied kindergarten training of the primary schools, to the original designs and the constructive work in different materials of the intermediate grades. It recognizes the importance of carrying forward manual training simultaneously with all other educational processes, but provides suitable training for different grades, reserving shop work and the use of wood and machine tools for pupils who have completed, or nearly completed the grammar school course.

"In accordance with the ideal thus presented there would be no necessity of large expenditures. The present facilities, with those that will be furnished by the addition to the high school, now in process of erection, will answer for the present, and the ideal manual training school will be a natural growth and development of the work now in progress, if it be properly fostered.

"Having presented a possible though somewhat distant future of the work under the charge of the committee, we desire to present our recommendation affecting its more immediate outlook. For the remainder of the present school year, we recommend the continuance of the present order of things. We recommend that this committee be authorized to prepare and submit a course of study covering a period of three years, to include the studies of English, mathematics, science, drawing and shop work, that at the end of the present school year, pupils who have finished the work of the grammar schools, may be admitted to either the high school or the manual training school; that the manual training school for the present be located in the basement of the high school building, its pupils reciting in English, mathematics and science, in the same classes and to the same teachers as the pupils of the high school.

"It seems important to the writer of this report that there should be no organic connection between the high school and the manual training school. Such a connection would hamper the latter in its development. If experience should show that it would be best to admit pupils to the manual training school from lower grades than those of the grammar schools, the change could then be made without disturbing the gradation of the high school.

"With regard to special training for girls, awaiting definite results from cities where expensive experiments are in progress, the committee recommends that for the present the board rests the matter with the general training given to all the pupils, both boys and girls, of the grade schools."

XIII. MISSOURI.

St. Louis Manual Training School.

This institution is the pioneer among special manual training schools in the United States, and has held high rank from the first. The ordinance establishing it, was adopted by the board of directors of the Washington University, June 6, 1879, and the school was opened September 6, 1880.

Article II of the ordinance declares that "Its object shall be instruction in mathematics, drawing and the English branches of a high-school course, and instruction and practice in the use of tools. The tool instruction, as at present contemplated, shall include carpentry, wood turning, patternmaking, iron chipping and filing, forge work, brazing and soldering, the use of machine shop tools and such other instruction of a similar character as may be deemed advisable to add to the foregoing from time to time.

"The students will divide their working hours, as nearly as possible, equally between mental and manual exercises."

The object of the work in general is thus stated by Mr. Woodward, the able and successful director: "*All the shop work is disciplinary; special trades are not taught, nor are articles manufactured for sale;* as a rule the products of the shop have no value except as exercises, illustrating typical forms and methods.

"The object of the school is education and none of the class exercises, whether in the shop, the drawing or the recitation room, can be supposed to have any pecuniary value. The most instructive tasks have no outcome except in the intelligence and skill of the student himself.

"The scope of any trade is too narrow for educational purposes Manual education should be as broad and liberal as intellectual. A shop which manufactures for the market and expects a revenue from the sale of its products, is necessarily confined to salable work, and a systematic and progressive series of lessons is impossible, except at great cost. If the object of the shop is education, a student should be allowed to discontinue any task or process the moment he has learned to do it well. If the shop were intended to make money, the students would be kept at work on what they could do best, at the expense of breadth and versatility. In a factory intellectual life and activity is not aimed at; its sole object is the production of articles for the market. In a manual training school everything is for the benefit of the boy; he is the most important thing in the shop; *he is the only article to be put upon the market.*

"Even in manual education the chief object is mental development

and culture. Manual dexterity is but the evidence of a certain kind of mental power; and this mental power, coupled with a familiarity with the tools the hand uses, is doubtless the only basis of that sound practical judgment and ready mastery of material forces and problems which always characterizes one well fitted for the duties of active, industrial life. Hence the primary object is the acquirement of that mental clearness and intellectual acumen which is the natural outgrowth of logical processes fully comprehended and intelligently executed. This thoughtful activity results in skill in the use of tools and materials. The production of specific articles is a secondary and far inferior consideration. Moreover the training must be *general*, that its possible economic application may have the widest range; we therefore abstract all the mechanical processes and manual arts and typical tools of the trades and occupations of men, and arrange a systematic course of instruction in the same. Thus, without teaching any one trade, we teach the essential mechanical principles of all.

"Accordingly, the shop training is gained by regular and carefully graded lessons designed to cover as much ground as possible, and to teach thoroughly the uses of ordinary tools. This does not imply the attainment of sufficient skill to produce either the fine work or exhibit the rapidity of the skilled mechanic.

"The manual training school is not an asylum for dull or lazy boys. It clearly recognizes the preëminent value and necessity for intellectual development and discipline. In presenting some novel features in its course of instruction, the managers do not assume that in other schools there is too much intellectual and moral training, but that there is too little manual training for ordinary American boys. This school exacts close and thoughtful study with tools as well as books. It proposes by lengthening the usual school day a full hour, and by abridging somewhat the number of daily recitations, to find time for drawing and tool work, and thus to secure a more liberal, intellectual and physical development—a more symmetrical education.

"'Manual training is essential to the right and full development of the human mind.' Certain intellectual faculties, such as observation and judgment in inductive reasoning cannot be properly trained except through the instrumentality of the hand. Manual training cultivates the judgment rather than the memory.

"In a manual training school properly so called, no attempt is made to cultivate dexterity at the expense of thought. No mere sleight-of-hand is aimed at, nor is muscular exercise of itself held to be of educational value. An exercise whether with tools or with books is valuable only in proportion to the demand it makes upon the mind for intelligent, thoughtful work. In the school shop the stage of mechanical habit is never reached. *The only habit actually acquired is that of thinking.* No blow is struck, no line drawn, no motion

regulated, from muscular habit. The quality of every act springs from the conscious will accompanied by a definite act of judgment. Such a limited training cannot, of course, produce a high degree of manual skill.

"We have distinctly stated that our pupils do not become skilled mechanics, nor do we teach them the full details of a single trade. The tools whose theory, care and use we teach are representative, and the processes employed just far enough to make every step clear and experimentally understood, equally underlie a score of trades. By the words, experimentally understood, is meant that it is not enough to know that a certain outline is to be produced or a certain adaptation is to be secured, but one must know just the forces to be directed, the motions needed, and in their order, and all as the result of the closest attention and steady intellectual activity.

"It occasionally happens that students who have special aptitudes in certain directions find great difficulty in mastering subjects in other directions. In such cases it is often the best course to yield to natural tastes, and to assist the student in finding his proper sphere of work and study. A decided aptitude for handicraft is, sometimes, coupled with a strong aversion to and unfitness for literary work which largely taxes the memory. There can be no doubt that, in such cases, more time should be spent in the laboratory, and less in the library and recitation room. On the other hand, great facility in the acquisition and use of language is often accompanied by a great lack of either mechanical interest or power. When such a basis is discovered, the lad should unquestionably be sent to his grammar and dictionary rather than to the laboratory or drafting-room. It is confidently believed that the developments of this school will prevent those serious errors in the *choice of a vocation* which often prove so fatal to the fondest hopes.

"One great object of the school is to foster a higher appreciation of the value and dignity of intelligent labor, and the worth and respectability of laboring men. A boy who sees nothing in manual labor but mere brute force, despises both the labor and the laborer. With the acquisition of skill in himself, comes the ability and willingness to recognize skill in his fellows. When once he appreciates skill in handicraft, he regards the skilful workman with sympathy and respect.

"Again, it is highly desirable that a larger proportion of intelligent and well-educated youth should devote their energies to manual pursuits or to the development of mechanical industries, both for their own sakes and for the sake of the occupations and for society.

"Undoubtedly the common belief is, that it requires no great amount of brains or intelligence to be a mechanic; and those who go through ordinary higher schools are not expected by their teachers to be mechanics. Every bright farmer's boy, every gifted son of a me-

chanic, if he but stay in school, is sure to be stolen away from the occupation of his father and led into the ranks of the 'learned professions.'

"This loss of the best minds, and the lack of the results of a generous education does much to give color to popular prejudice, and to keep down mechanic arts in the estimation of all. This result is most unfortunate for society. It creates distinctions which ought not exist, and gives rise to false estimates of the comparative value of the various kinds of intellectual culture. 'The successful conduct of any business demands and develops a special scholarship, which is not less valuable as a means of discipline because it is useful as a source of wealth. The business man may be narrow, but so may the scholar; and in either case, the narrowness results not so much from the necessities of the vocation, as from the character of the man.'

"Hitherto, men who have cultivated their minds have neglected their hands; and those who have labored with their hands have found no opportunity to cultivate their brains. The crying demand to day is for intellectual combined with natural training. It is this want that this school aims to supply. Its motto is:

"'THE CULTURED MIND, THE SKILFUL HAND.'

"It is not assumed that every boy who enters this school is to be a mechanic. Some will find that they have no taste for manual arts, and will turn into other paths—law, medicine, or literature. Some who develop both natural skill and strong intellectual powers will push on through the polytechnic school into the realms of professional life as engineers and scientists. Others will find their greatest usefulness as well as highest happiness in some branch of mechanical work into which they will readily step when they leave school. All will gain intellectually and morally by their experience in contact with *things*. The grand result will be an increasing interest in manufacturing pursuits, more intelligent mechanics, more successful manufacturers, better lawyers, more skilful physicians and more useful citizens."

ADMISSION.

Candidates for admission to the first year class must be at least fourteen years of age, and must pass a good examination on the following subjects:

1. Arithmetic, including the fundamental rules; common and decimal fractions; the tables of weights, measures and their use; percentage; interest; and analysis of miscellaneous problems. Candidates will be examined orally in mental arithmetic, including fractions, mixed numbers and the higher multiplication table.
2. Common school geography, including map drawing from memory.
3. Spelling and penmanship.

4. The writing of good descriptive and narrative English, with the correct use of capitals and punctuation.

Candidates for the second-year class must be at least fifteen years of age. All that is specified above will be required of them, and, in addition, the book studies of the first-year class.

Similar requirements apply to those desiring to enter the third-year class.

When candidates can present certificates of having completed a thorough course of study preparatory to a high school, or of having done satisfactory work in a high school or school of equal grade, they may be admitted either without examination or on one less formal in character.

The course of instruction covers three years, and embraces five parallel lines—three purely intellectual, and two both intellectual and manual—as follows.

First.—A course of pure mathematics, including arithmetic, algebra, geometry and plane trigonometry.

Second.—A course in science and applied mathematics, including physical geography, botany, natural philosophy, chemistry, mensuration and book-keeping.

Third.—A course in language and literature, including English grammar, spelling, rhetoric, composition, literature, history and the elements of civics and political economy. Latin and French are introduced as electives with English or science.

Fourth.—A course in penmanship, free-hand and mechanical drawing.

Fifth.—A course of tool instruction, including joinery, wood-turning, molding, patternmaking, brazing, soldering, forging and bench and machine work in metals.

DRAWING.

The course of drawing embraces three general divisions:

1. *Free-hand Drawing*, designed to educate the sense of form and proportion, to teach the eye to observe accurately; and to train the hand to rapidly delineate the forms either of existing objects or of ideals in the mind.

2. *Mechanical Drawing*, including the use of instruments geometric construction; the arrangement of projection, elevations, plans and sections; also the various methods of representing shades and shadows with pen and brush.

3. *Technical Drawing or Drafting*, illustrating conventional colors and designs; systems of architectual or shop drawings. The drawings required familiarize the pupil with the proportions and details of various classes of machines and structures.

Students have no option or election as to particular studies, except as regards Latin and French; each must conform to the course as laid down and take every branch in its order.

The arrangement of studies and shop-work by years is substantially as follows:

FIRST YEAR.

Arithmetic, completed, Algebra, to equations.

English language, its structure and use. Study of selected pieces. History of the United States.

Latin grammar and reader may be taken in place of English.

Introduction to science. Physical geography, botany.

Drawing, mechanical and free-hand. Penmanship, carpentry and joinery. Wood-carving. Wood-turning.

SECOND YEAR.

Algebra, through quadratics. Geometry begun.

Natural Philosophy. Experimental work in the physical laboratory. * Principles of mechanics.

English composition and literature. Rhetoric. English History.

Latin [Cæsar] may be taken in place of English and history.

Drawing, line-shading and tinting machines. Development of surface, free-hand detail drawing, isometric projections.

Shop-work, forging, drawing, upsetting, bending, punching, welding, tempering; pattern making, casting with plaster, soldering and brazing.

THIRD YEAR.

Geometry continued through plane and solid. Mensuration.

English composition and literature. Civics and political economy.

French or German may be taken in place of English and history, or in place of the science study.

Physiology. Element of chemistry. Students who have taken Latin at and who intend to enter the Polytechnic school after completing the course in this school, will take history in the place of physiology and chemistry.

Book-keeping.

Drawing, brush-shading, machine and architectual drawing.

Work in the machine shop. Bench work and fitting, turning, drilling, planing, screw-cutting, etc. Execution of projects.

At least once a week in every class the literary work takes the form of reading and studying classic English or English composition, and the science study is omitted to give more time for such work. In the lower classes, penmanship takes the place of drawing occasionally, according to needs.

The shop instruction is given similarly to laboratory lectures. The instructor at the bench, machine or anvil, fully explains the principles to be used or illustrated, and executes in the presence of the whole class the day's lesson, giving all needed information, and at times using the blackboard. When it is possible, the pupils make working drawings of the piece or models to be executed, and questions are asked and answered, that all obscurities may be removed. The class then proceeds to the execution of the task, leaving the instructor to

*In connection with the physical laboratory is a special workshop containing work benches, hand tools, and two lathes, driven by a small upright steam engine built by the class of 1886.

give additional help to such as need it. At a specified time the lesson ceases and the work is brought in, commented on and marked. It is not necessary that all the work assigned should be finished; the essential thing is that it should be well begun and carried on with reasonable speed and accuracy.

Students who complete the course with credit in all its details receive the diploma of the school and are entitled to certificates which will admit them to the freshman polytechnic class of the undergraduate department without examination, *provided they have the required knowledge of French, German, or Latin and history.*

RESULTS.

The results of his experience are thus summarized by the director of the school:

"The school is now in its eighth year. From the start it has been well patronized, and vacant seats have been few. The enrolment shows a steady increase. The zeal and enthusiasm of the students have been developed to a most gratifying extent, extending into all departments of work. The variety afforded by the daily programme has had the moral and intellectual effect expected, and an unusual degree of sober earnestness has been shown. The wholesome moral effect of a course of training which interests and stimulates the ardor of the student is most marked. Parents observe the beneficial influence of *occupation.* The suggestions of the day fill the mind with healthy thoughts and appetites during the leisure hours. Success in drawing or shop work has often had the effect of arousing the ambition in mathematics and history, and *vice versa.* Gradually the students acquire two most valuable habits which are certain to influence their whole lives, namely, precision and methods.

"The habit of working from drawings and to nice measurements has given the students a confidence in themselves altogether new. This is shown in the readiness with which they undertake the execution of small commissions in behalf of the school, and the handiness which they display at home. From the testimony of parents the physical, intellectual and moral effect of the school is exceedingly satisfactory.

"The school has served to demonstrate the entire feasibility of incorporating the elements of intellectual and manual training in such a way that each is the gainer thereby; and that there is a public demand for an education which shall insure the most valuable mental discipline, at the same time that it gives knowledge and skill of great intrinsic worth."

In May, 1886, Prof. Woodward, gave the following brief statement of the fruits of manual training, in the *Journal of Education:*

"The value of manual training, when properly combined with literary, scientific and mathematical studies, will be shown in various ways.

"1. Science and mathematics will profit from a better understand-

ing of forms, materials, and processes, and from the readiness with which their principles may be illustrated.

"2. Without shop-work, drawing loses half its value.

"3. Correct notions of things, relations and forces, derived from actual handling and doing, go far toward a just comprehension of language in general; that is, manual training cultivates the mechanical and scientific imagination, and enables one to see the force of metaphors in which physical terms are employed to express metaphysical truths.

"4. Manual training will stimulate a love for simplicity of statement, and a disposition to reject fine sounding words whose meaning is obscure.

"5. It will awaken a lively interest in school, and invest dull subjects with new life.

"6. It will keep boys and girls out of mischief, both in and out of school.

"7. It will keep boys longer at school.

"8. It will give boys with strong mechanical aptitudes, and fondness for objective study, an equal chance with those of good memories for language.

"9. It will materially aid in the selection of occupations when school-life is over.

"10. It will enable an employer of labor to better estimate, the comparative value of unskilled and skilled labor, and to exercise a higher consideration for the laboring man.

"11. It will raise the standards of attainments in mechanical occupations, and invest them with new dignity and worth.

"12. It will increase the bread-winning and home-making power of the average boy, who has his bread to win and his home to make.

"13. It will stimulate invention. The age of invention is yet to come, and manual training is the very breath of its nostrils.

"14. We shall enjoy the extraordinary advantage of having lawyers, journalists and politicians with more correct views of social and national conditions and problems."

To the above he adds in 1887:

"15. It will help to prevent the growth of a feeling of contempt for manual occupations and for those who live by manual labor.

"16 It will to a certain extent readjust social standards in the interest of true manliness and intrinsic worth.

"17. It will accelerate the progress of civilization by greatly diminishing the criminal and pauper classes, which are largely made up of those who are neither willing nor able to earn an honest living.

"18. It will show itself in a hundred ways in the future homes of our present pupils, on the one hand, in the convenience and economy of useful appliances, on the other, in evidence of good taste in matters of grace and beauty."

XIV. NEBRASKA.

Omaha Public Schools.

Manual training was introduced into the public schools of Omaha about four years ago. The attitude of the public toward it, and its general plan and working are indicated by the following statement taken from the third annual report of the committee on manual training:

In September of 1887, everything was in good working order, but the delays of the previous year still hindered the expected progress in this department; still, in all the classes, first and second year, the attendance nas been seventy-five.

The first year is devoted to carpentry, joinery and wood-turning; the second year to wood-turning, carving and molding. The third year pupils will have molding and blacksmithing, chipping and filing, though at present a strict adherence to the proposed course of study is not practicable.

Additional expenditures have been made during the past year as follows:

Engine,	$325 00
Boiler and setting,	575 00
Wood carving tools,	150 00
Extra tools for turning,	70 00
Total,	$1,120 00

The permanent investment has been about $3,000. There will be needed to prepare for the third year's work about $1,000 more. For the sum of $1,000 there will be secured for this department a complete outfit of tools for carpentry, wood carving, turning, molding and blacksmithing, with the necessary machinery, large enough to provide for eighty pupils.

The pupils have done excellent work in their other studies, and your committee think that the manual training school has passed beyond the experimental stage and may fairly be considered as an established part of the high school course. Your committee would call attention to the fact that the attendance of girls has increased and that they have done excellent work.

The public, as well as some members of the board, are still laboring under the mistake of supposing that the purpose of this department is to make mechanics. Again your committee would reiterate that the purpose of this work is to train the eye and the hand to work together, to familiarize the pupils with the use of tools, and to develop their

self-reliance. The training will be valuable, whatever the students may decide to do after they graduate; if they conclude to follow a trade, they can advance more rapidly than would otherwise be possible.

The expense per pupil is no larger than for instruction in any other special study taken by the same number of pupils. It cost less for a pupil to take manual training than to take Latin or Greek. When we remember that the pupils in the manual training school spend two study hours each day in the shop or in the drawing-room, it is evident that the teacher of manual training is giving the same amount of time to seventy-five pupils which the teacher of physics or chemistry would give to one hundred and fifty pupils. To determine the expense per pupil, the expenses of the department are divided by the number of pupils. To compare the expenses of physics with that in manual training, taking into account the study hours, the number of pupils in the manual training school should be multiplied by two which would make the expense per pupil $14 a year. Your committee is further convinced that the advantages derived from manual training are much greater than can be derived from any other study. Indeed, the pupils in this department have really two studies—drawing and shop work. For not only do the students in the manual training school learn to use tools and to work from drawings, but to reason by the practical application of effects to their appropriate causes. They are taught to put into practice the knowledge they have acquired, thus fitting them for practical life.

Manual training is mainly given to boys, but your committee have become convinced that girls should have a practical training suited to their needs, and to supply this training have, in connection with the committee on the high school, opened a department of domestic economy. A competent teacher has been secured, who, for the balance of the year, will give instruction in cooking to the girls of the high school and the eighth grade and to past graduates of the high school. Should this instruction meet with general favor and bring forth the results expected, instruction in the future may be given in sewing, cutting and fitting garments, and such other branches of domestic economy as will assist our girls in fitting themselves for useful lives. This instruction has been given in some of the eastern cities with gratifying success, and your committee believe that this new course of study will do much for the school system of Omaha.

Your committee refer with pleasure to the change in public sentiment with regard to the manual training department. When opened it had few friends, now it meets with very general approval. There have been vexatious delays in putting the manual training school into good shape—a lukewarmness on the part of some members of the board and a decided opposition by some of the daily papers. The school is now in good condition and well equipped. The board looks upon it

with more favor, and the opposition from the press has ceased. The same obstacles will be encountered by the school of domestic economy but will also be overcome, and in the future no one would dream of giving up either of these departments.

Many visitors from the State and other States have visited the school during the past year and, as a result of these visits, plans for similar schools have been discussed and in several instances put in operation. So that the manual training school of Omaha is not only educating the pupils who attend it, but the people of several States. Inquiries as to our methods come from cities in the east and west, Omaha being the pioneer in estalishing manual training as a part of the school system. Through this school more attention has been attracted to Omaha on the part of educators than by anything else connected with our schools.

The committee recommend that before the end of the present school year, the necessary tools and machinery for the teaching of blacksmithing be procured, so that at the beginning of next year everything may be ready for a third year's course.

EXPENSES.

For the convenience of many from other cities who make enquiries as to the cost of this department, we give the following statistics:

Machinery.

Twenty benches for eighty pupils,	$286 00
Tools for eighty pupils,	510 00
Lathes for eighty pupils,	580 00
Shafting, pullies and belting,	188 45
Wood-turning tools,	200 00
Setting up lathes.	200 00
Wood-carving tools,	150 00
Molding benches and tools,	200 00
Engine,	325 00
Boiler,	300 00
Setting boiler,	275 00
Blacksmithing outfit (probable).	750 00
	$3,964 45

Current Expenses.

Salary of teacher,	$1,100 00
Salary of engineer,	700 00
Material,	100 00
Wear of tools,	100 00
Fuel,	100 00
	$2,100 00

XV. NEW JERSEY.

1. Elizabeth Public Schools.

The city superintendent writes, October 1, 1888:

"A few years ago we introduced industrial drawing into our schools, not without considerable opposition however. To-day it is probably more highly appreciated in this community than any other department of our school work and we are enlarging our borders, having secured State aid for manual training under recent legislation and appointed an assistant to Miss Habberton, our very competent instructor in this department.

"I send you herewith a copy of our course of instruction in which, as you will see, considerable attention is given to industrial drawing. I also enclose a copy of Miss Habberton's last report. With the increased means at our command we have decided to introduce new features this year, as clay modeling, sewing for the girls and working in wood for the boys.

"We pay Miss Habberton $1,000 per annum and her assistant $600."

Report of industrial drawing in public schools of Elizabeth, N. J., 1887–8:

The industrial work in the public schools of Elizabeth, during the year 1887–8 was necessarily confined to drawing and cutting and making. The drawing was industrial in character, half the year being given to mechanical drawing, the other half to decoration and original design.

In the primary department the mechanical drawing was combined with free-hand object-drawing, the familiar objects of the class room frequently serving as models, i. e., books, desks, door, window, etc. In decorations, specimens of simple historic borders and figures were given as studies, and original designs made weekly. Facility in designing was much aided by paper cuttings and their arrangements known as parquety.

In the lower grammar grades the development of surfaces was practically taught by drawing, cutting and pasting geometrical solids from wooden models.

In the higher grammar grades, working drawings were introduced, *i. e.*, plan and elevations to scale from wooden models and various features of the class room as door, window, side or end of room, etc. The decorative work throughout the grammar department included study of historic forms and designing from the same for borders, figures and surfaces, floral decoration receiving special attention during the spring months when studies were made from natural forms.

The mechanical work in the high school embraced a thorough course in geometrical construction, and perspective both parallel and angular.

Designing for decoration was made a specialty; the designs both from historical and floral motives were of an unusually high character. Ornamental lettering was also taught.

All good designs were executed in India ink with pen or brush.

The public schools of the city of Elizabeth are arranged in three departments—primary, grammar and high schools; the primary in six grades; the grammar in four grades; the high school in three grades.

I. PRIMARY DEPARTMENT.

The studies pursued in the primary department are music, calisthenics, oral instruction, language lessons, reading, spelling, arithmetic writing, drawing, geography.

The course in drawing, beginning with the sixth (lowest) class is laid out as follows.

Sixth Class.—Taught on ruled slates and prepared paper. Straight lines. Simple forms.

Fifth Class.—Taught on ruled slates and prepared paper. Straight lines and simple forms.

Fourth Class.—Taught on ruled slates and prepared paper; straight and curved lines, simple forms.

In this and preceding grades should be taught the proper position of pupil, book or slate and pencil. Slates or paper with quarter-inch cross-lines should be used. Lines should be drawn from blackboard illustrations, then from dictation, and lastly from memory. Parallel lines, horizontal, vertical and oblique. Bisected, trisected, quadrisected. Right angles, squares, with diameters and diagonals. Combinations of lines of one, two, three or four quarters to make attractive borders. Squares of two, three or four inches as outlines of designs.

Patterns given on Steiger's cards will assist the teacher and encourage pupils to originate designs.

Third Class.—Lines, angles and quadrilaterals of dictated meaurements with rule and free-hand, from models and familiar objects and blackboard illustration.

Borders and figures with straight lines and combinations of straight and curved lines.

Squares with diameters, diagonals and other dividing lines. Original designs weekly.

Second Class.—Review of principles given in third class. Door and window of room (dictated measurements).

Appearance of rectangular objects in various positions (perspective efforts, but no technical terms, except "vanishing point"), cubes, boxes, steps, books, etc.

Simple and reversed curves. Circle seen as an eclipse, illustrated by vase forms, tumblers, pail, chip basket.

Designing as in third class, using greater variety of combinations, interlacing and new enclosing forms.

First Class.—Review of principles given in second class. More varied illustrations of the same. Curves of a more subtle character, with a few simple finals, and a few simple leaf and flower forms to be use in original designs.

Brush work with India ink for selected pupils.

II. GRAMMAR DEPARTMENT.

The studies pursued in the grammar department are, music, oral instruction, language lessons, reading, spelling, arithmetic, writing, drawing, geography, United States history, grammar, bookkeeping, anatomy, physiology and hygiene.

The course in drawing is as follows:

Fourth Class.—Four months to be given to mechanical work, and six months to free-hand drawing and designing. All mechanical work to be done from models, with blackboard illustrations, or occasional dictation. Rulers and compasses to be the only tools. Weekly designs from all pupils. Good designs to be enlarged and finished with brush.

Review of principles given in first primary class, with different illustrations. Developed surfaces or patterns of cube, triangular and rectangular prisms, quarter section of cube, Greek cross and other simple solids; all to be cut from paper or pasteboard and fastened together. Designing. Copying from blackboard and drawing from dictation, borders, figures and designs for indefinite surfaces, as oil cloth, wall paper, etc.

Motives given for conventional flowers forms and simple combinations of straight and curved interlacing forms, from which to make interlacing designs.

Third Class.—Mechanical drawing similar to fourth class, but to scale instead of from dictated measurements. A great number of patterns from models; also working drawings of the same with plan and elevation.

Designing, similar to fourth class, using different patterns as copies, and different motives for design. Designs to be adapted to greater variety of enclosing forms. Spiral forms with classical and flower Ornaments. Elements of lettering.

Second Class.—All mechanical drawing to scale.

Elevations at $\frac{1}{4}$ inch and $\frac{1}{8}$ inch scale of window, door, side of room, etc. Working drawings continued from more difficult models, cylindrical, conical and pyramidal sectional views.

Designing—continuation of principles as in third class. Variety of leading lines as motives, and new ornament forms. Simple specimens of Greek, Celtic and Moorish forms for copying from blackboard, and for imitation in original work. New leaf and flower forms. Good work to be finished with brush. Lettering continued.

First Class.—Mechanical drawing similar to second class, but more advanced. Foreshortened views in projection of surfaces at different angles, as in triangular, pentagonal and hexagonal prism, etc. Appearance of the same models used in working drawings. Two or three models combined in one study.

Designing—review of principles given in second class, with different illustrations. New motives from Egyptian, Persian and Arabian ornament. Advanced lettering with original monogram.

2. The Stevens Institute of Technology.

The plan of instruction is designed to be such as will best fit young men of ability for positions of usefulness in the departments of mechanical engineering, and in kindred scientific pursuits.

With this view there is afforded:

1. A thorough training in the elementary and advanced branches of mathematics, and their application to mechanical constructions.

2. A systematic course in the theory of machine construction, and a study of existing systems.

3. The subject of mechanical drawing (which may well be called the language of engineering) forms a separate department, to which much time and attention are devoted. The course comprises the use of instruments and colors, descriptive geometry, shades, shadows and perspective, and the analysis of mechanical movements—the principles involved being at once and continuously applied in the construction of working drawings from measurements of machines already built, as well as in making original designs.

4. An extensive course of manual exercises in shop practice is combined with a course of experimental mechanics, to form a separate department, which aims to coöperate with the departments of engineering, mechanical and drawing, so as to bear to them the same relation as the physical and chemical laboratories do to the class-room work in physics and chemistry. Its courses, aside from the introduction of the student to the functions of tools, etc., are directly supplemental to the department of mechanical drawing, by familiarizing the student with the use of working drawings in the shop, and by the embodiment of the theoretical principles of mechanism in the form of exercises in gear cutting, etc., and directly supplemental to the departments of engineering and mechanics, by re enforcing the apprehension of theoretical principles through the performance of exercises in the course of experimental mechanics.

5. Arrangements of an unsually perfect character are made to give a thorough, practical course of instruction in physics, by means of physical laboratories, in which the student is guided by the professor of physics in experimental researches bearing upon the subjects of his special study. Thus the students practice methods of making precise measurements of lengths, angles, volumes, weights and time, and then apply these processes in the measurements of magnitudes relating to the phenomena of light, sound, heat, electricity and magnetism. By this plan of instruction the knowledge of physical facts and laws is indelibly impressed on the mind of the student, while, at the same time, he is trained in methods of experimental investigation which will be of great value to him in the actual practice of his profession of mechanical engineer.

6. The subject of chemistry is taught, chiefly by experimental work

in the laboratory, with accompanying lectures and class-room instruction. It is believed that in this manner only can students be made thoroughly conversant with the subject.

7. The French and German language form an essential part of the course of instruction, since they are indispensable to the engineer and man of science as the vehicles of a vast amount of information, and also as affording that kind of mental culture which mathematical and physical science, if followed exclusively, would fail to supply. A course in Spanish was introduced in 1888, having especially in view the extensive use of that language in portions of America.

8. A department of belles lettres furnishes the means of cultivating literary taste and a facility in the graceful use of language, both in speaking and writing, which are as desirable in the engineer and man of science as in the classical student.

9. The subject of applied electricity is taught in a thorough manner by means of complete appliances in the way of instruments for electrical measurements, dynamo machines, electric lamps and the like, so as to fit graduates for responsible positions in connection with electric lighting and other similar companies.

No applicant under the age of seventeen years is admitted to examination for the freshman class unless the faculty is satisfied that he is able to bear the burden of the institute course without detriment to his health, nor is any applicant under the age of seventeen allowed to enter his class unless his examination shows proof of unusual profiency.

ADMISSION.

The examinations for admission include the following subjects:

Arithmetic Algebra.—Simple equations, theory of radicals, equations of the second degree, arithmetical and geometrical progression, permutations, biominal theorem, indeterminate coefficients, and the summation of series. Great importance is attached to a thorough knowledge and readiness in solution of simultaneous equations of the second degree, and the reduction of radicals. *Geometry.*—All of plane, solid and spherical geometry; *Plane trigonometry*, especially the numerical solution of plane triangles; *English Grammar: Geography; Composition; Universal History; Rhetoric; French.*

In addition to the above applicants for advanced standing must pass examination in the subjects already completed by the class to which admission is desired.

FEES AND EXPENSES.

The fees for each year of the entire course, for instruction and the use of instruments, are one hundred and fifty dollars, for students at the time residing in the State of New Jersey. Those not residing—

i. e. coming across the river each day from New York, or the like—are charged seventy-five dollars extra.

A charge of five dollars per term is made to each student for chemicals used in the laboratory.

In the department of shop work the student is expected to pay for the material used; the total cost for the entire course does not exceed sixty-five dollars.

Each student is required, on admission, to make a deposit of ten dollars to meet incidental expenses, such as those for drawing materials or special chemical supplies. This deposit can only be withdrawn when he graduates or leaves the institute.

The annual expenses of a student for books, board and tuition, are estimated at from five hundred to six hundred dollars.

COURSE OF STUDY.

The full course of the institute occupies the period of four years, each year being divided into a supplementary term, during which the sophomore, junior and senior classes devote eight hours per day to the department of experimental mechanics and shop-work, and three regular terms.

SYNOPSIS OF STUDIES.

First Year.

First Term. Mathematics—Logarithms, Plane and Spherical Trigonometry, with practicable applications to engineering problems;
Mechanical Drawing—Elementary Projections;
Languages—French;
Physics—General Properties of Matter, Inductive Mechanics;
Belles-Lettres—Fowler's English Language, Lectures, Essays;
Shop-Work.

Second Term. Mathematics—Theory of Equations, Analytical Geometry and Calculus; Exercises in Mathematical Laboratory;
Mechanical Drawing—Elementary Projections;
Languages—French;
Physics—Pneumatics, Laws of Vibratory Motions, and Acoustics;
Belles-Lettres—Deductive Logic;
Shop-Work.

Third Term; Mathematics—Analytical Geometry and Calculus; Exercises in Matematical Laboratory;
Mechanical Drawing—Elementary Projections;
Languages—French;
Physics—Light;
Belles-Lettres—Inductive Logic;
Shop-Work.

Supplementary Term. Shop-Work

Second Year.

First Term. Mathematics—Differental Calculus;
Mechanical Drawing-Machine Drawing from Sketches, Descriptive Geometry;
Language—French concluded, German;
Physics—Heat and Meteorology;
Belles-Lettres—English Literature;
Chemistry—Theoretical and General;
Shop-Work.

Second Term. Mathematics—Integral Calculus;
Mechanical Drawing—Machine Drawing from Sketches, Descriptive Geometry;
Languages—German;
Physics—Magnetism and Electricity;
Belles-Lettres—English Literature;
Chemistry—Theoretical and General;
Shop-Work.

Third Term. Mathematics—Integral Calculus, Applications;
Mechanical Drawing—Machine Drawing from Sketches, Descriptive Geometry;
Languages—German;
Physics—Electricity;
Belles-Lettres—English Literature;
Chemistry—Theoretical and General;
Shop-Work.

Supplementary Term. Shop-Work.

Third Year.

First Term. Mathematics—Analytical Mechanics;
Mechanical Drawing—Kinematics, Machine Drawing, Descriptive Geometry;
Languages—German;
Physics—Lectures on the use of instruments for making Precise Measures and on their Applications to the Practical Work in the Physical Laboratory;
Chemistry—Qualitative Analys s;
Engineering—Strength, Elasticity and other properties of Materials of Engineering, Construction of Foundations, Framing;
Shop-Work.

Second Term. Mathematics—Analytical Mechanics;
Mechanical Drawing—Kinematics, Machine Drawing, Descriptive Geometry;
Languages—German concluded;
Physics—Lectures (see First Term);
Chemistry—Qualitative and Quantitative Analysis and Metallurgy;
Engineering—Mechanism of Engines, Boilers, Lectures;
Shop-Work.

Third Term Mathematics—Analytical Mechanics;
Mechanical Drawing—Kinematics, Machine Drawing;
Physics—Lecture (see First Term);
Chemistry—Quantitative Analysis;
Engineering—Machinery, Hydraulic Engineering, Engine Design, Lectures;
Shop-Work.

Supplementary Term. Experimental Mechanics;

Fourth Year.

First Term. Mathematics—Construction, Adjustment and Use of Engineering Instruments, Graphical Statics, Selected Mathematical Problems;
Mechanical Drawing—Machine Drawing and Design;
Physics—Laboratory Work;
Engineering—Water, Wind and Traction Engines, Furnace Design, Lectures;
Applied Electricity—Lectures and Laboratory Work;

Second Term Mathematics—Theory of Bridges and Roofs, with Graphical Statics Applied, Selected Problems;
Mechanical Drawing—Machine Drawing and Design;
Physics—Laboratory Work;
Engineering—Thermo-dynamics, Steam and Air Engines, Engine Construction, Lectures;
Applied Electricity—Lectures and Laboratory Work.

Third Term. Work on Graduating Theses, including Experimental Investigation and General Research.

DEPARTMENT OF MATHEMATICS AND MECHANICS.

These subjects are taught in close connection, not only because such treatment is specially suitable for students of engineering, but also because mathematics has its deepest foundations in the mechanics of nature.

To this end trigonometry is accompanied with practical applications to such engineering problems as will emphasize important formulas and impress them upon the memory. Such problems are devised and executed with special reference to system and accuracy in obtaining data and in calculating results, and to give sufficient practice with logarithmic and other tables.

In order that students may be thoroughly grounded in the fundamental facts and principles of analytical mechanics before commencing a mathematical treatment of the subject, a series of practical exercises, with models, in the *Mathematical Laboratory*, is given, and these are so arranged as to teach the student, also the fundamental principles of analytical geometry and the calculus in advance of the full treatment of those subjects in the class-room.

MECHANICAL DRAWING.

In the organization of the department of mechanical drawing, the object aimed at is to make the course of instruction thorough, practical, of direct utility, and comprehensive.

The requirements of many of the industrial arts at the present day are such as to necessitate the delineation, not only of what already exists, but of what is yet to be made. Both demand a knowledge of the science of drawing, and the latter especially involves a certain exercise of the imagination, in order to form clear physical conceptions of the particular design in contemplation, not only in regard to its appearance as a whole, but as to the relations and proportions of its parts.

This ability to form a vivid and distinct mental image, as well as to fix it permanently by accurate representations, though useful to all, is more emphatically so to the mechanical engineer, who is daily called on, not to copy what has been done, but to do what has not been.

These considerations have been kept distinctly in sight in the conduct of this department; the matter taught and the method of teaching have been selected with the view of giving the student a firm grasp of principles, of developing and strengthening his imaginative power, and giving him direct practice in the application of both. The course adopted to attain these ends may be briefly outlined as follows:

The foundation is laid by practice in the simple drawing of lines, in order to acquire facility in the manipulation of the instruments. The exercises selected are such as will be of subsequent use, arranged in a progressive order; beginning with geometrical constructions involving straight lines and circular arcs only, and ending with the more complex curves, such as the eclipse, helix, epicycloids, etc. Attention to symmetry, proportion and arragement is enforced from the first, the diagrams not being copied, but constructed.

Elementary studies of projection are then taken up; the method adopted being that of beginning by making the drawings of a solid object bounded by plain surfaces, such as prism, in various positions, and proceeding by degrees to the similar treatment of more complex forms. The relation between the drawing and the thing drawn is more easily grasped at first, when the latter is not a mere abstraction, like a line or plane in space, but a definite and tangible object; and when the subject is

presented in this manner, no difficulty is experienced with the similar problems of intersection and development, which not only bring the imaginative faculty into play, but afford practical exercises of great utility.

The next step is to the drawing of parts of machines from actual measurements. The student is at once set at work as a draughtsman; a part or the whole of some piece of mechanism is assigned to him, which he is to study, to measure, to sketch, and finally to draw; the requirement being, exactly as if he were employed in the drawing office of an engineering establishment, that he shall produce complete working plans, from which the original could be replaced were it destroyed. He thus acquires some knowledge of details, and is taught to observe closely, while at the same time his previously acquired skill and information are practically applied

Simultaneously with this, descriptive geometry is taken up as an abstract science; not as an ultimate object, but its practical applications being always kept in view, it is made a means to an end, and that end is the acquirement of such a mastery of the principles of drawing, that the student shall be able to cope with any problem when it arises in the course of his practice. The identity of the operations with those of mechanical drawing is never lost sight of, and the problems are frequently put in a practical form. This is not done exclusively, however, because they afford, in the abstract, the best possible exercise of the imaginative power. The study is continued in application to shades and shadows and to linear perspective; in connection with which the principles of ariel perspective, as applied to the shading of mechanical objects, are explained, and a little time is given to practice in the execution of finished drawings. But the ability to make elaboratory shaded pictures is regarded as the least valuable of the qualifications of a mechanical draughtsman. However great his skill in this way may be, the accomplishment will save him but little in his professional career if it be acquired at the expense of accuracy, or facility in the construction of working plans. Therefore, while it is designed to impart a thorough understanding of the principles involved in making such drawings, comparatively little time is devoted to their practical execution.

The mechanical engineer plans machines, and these move; consequently, the study of the laws of their motions is an important branch of his education; and it is properly given a place in this department, since to make the drawings of a piece of mechanism implies the making of them so that each part shall move in harmony with the rest, and the depth of engineering disgrace is reached when, through any oversight, one part interferes with another. This study might also, especially when the more complicated mechanical movements are considered, be regarded as a branch of applied mathematics of the higher order. But, however, these laws may be investigated, this fact remains; that for the purposes of the draughtsman the results must be translated into his language and expressed in a graphic form—the ways of the analyst are not his ways, and the algebraic formula must be replaced by a diagram. Fortunately, however, the investigations may be made, at least as applied to by far the larger and more important part of the motions with which he has to deal, in his own language and by his own methods. In this part of the course, therefore, the geometry of mechanism is taught by graphical construction alone, practical exercises in the plotting of mechanical movements, the drawing of the various forms of gearing, the construction of curves representing varied motion and the like, being introduced from time to time.

Further, the course includes some practice in actual planning. A subject being assigned or selected the student proceeds to work it up as though already engaged in the active pursuit of his profession; making first a skeleton diagram of the movement, and sketching in the proposed arrangement of parts, he calculates the strength and proportion of these, modifying the original plan when it is found necessary to do so by the results of these calculations, then making drawings of each part in detail, and finally a general plan of the completed design; a general supervision being exercised over the work while in progress, and hints and suggestions as to details and arrangement being made as occasion arises.

It should be stated, also, that much care is being taken throughout the course to form the habit of correct judgment in determining what drawings to make of any subject in hand, and how to arrange them most advantageouly. Written instruc-

tions in regard to this are exceedingly meagre, and yet it is a very important matter. The object is to show the workman what to make and how to make it and experience proves that it is very easy to produce drawings which are perfectly correct, and yet do not clearly illustrate the objects represented. Nothing facilitates the operation of the mechanic more than to have a set of working plans which are clear, easily read, and connectedly arranged, and it is almost as important that the draughtsman should know just what to draw, as that he should be able to draw it well from the first to the last; therefore, the student is taught the necessity of exercising his judgment in the direction, as well as care and forethought in all that he does.

Summarily, then, the object of the course is not merely to teach the student to read and write certain set phrases of the graphic language with ease and fluency, but to enable him to wield it with power and for a purpose. He is taught not so much to memorize as to compose; he is encouraged to think for himself, and to acquire vigor and facility by giving expression to new ideas; his practice during the course being made as nearly as possible to resemble that upon which he will enter at its close.

ENGINEERING.

The chief aim of this department is to instruct the student in those subjects which will enable him to design a machine, or a plant of machinery, in accordance with scientific principles; or to review such as have been previously made.

During the junior year the studies will pertain to the mechanical properties of building materials, foundations of structures, the efficiency of machines and the general principles of designing machinery.

Problems are frequently given under each of these heads to make certain that the student can apply the principles which he has studied to practical problems.

During the senior year the principles of energy are studied in connection with such motors as: hydraulic motors, windmills, steam and air engines, pumps, compressors and special machines of known types. As much time as circumstances permit is given to thermo-dynamics and its applications. Problems requiring designs or numerical solutions are occasionally given. Instruction is given chiefly through text-books and frequently but informal lectures.

The plan of the instruction consists in requiring labor on the part of the student; ascertaining by suitable tests if knowledge is acquired, and giving assistance when needed.

At the close of the course a "Graduating Thesis" is required of every student, in which he is expected to exhibit his proficiency by designing and describing the construction and management of some machine, by planning some manufacturing establishment, giving bills of materials and estimates of cost; or by describing some original research, in the course of which he has investigated some subject of importance to the profession and obtainned new and valuable information and data capable of practical application in mechanical engineering. These are deposited in the institute and are open for inspection at any future time.

Instruction in regard to the proper materials for tools—their forms and modes of use in the construction of machines, is given in "Shop-work."

Experiments to test certain theoretical principles are given in the "Course of Experimental Mechanics."

SHOP WORK.

The workshop, fitted up by President Morton, and formally presented by him to the trustees, on the 14th day of May, 1881, is provided with machine and other tools, so as to accomodate fifty students at one time.

The "workshop" course of the institute is intended to supply the student with a knowledge, as complete as possible, of the best existing appliances, methods, and processes necessary to the construction of such mechanical designs as the theoretical part of the institute's course will enable him to originate.

In accordance with this plan, the institute is provided with a machine and carpenter shop, and iron and brass foundry, and a blacksmith's shop, in which the student is first sufficiently familiarized with the working of wood and metal, to enable him to recognize and appreciate differences in machines, tools and methods, of manipulation in founding and blacksmithing, after which he is taken to certain large manufacturing establishments, so selected as to enable him to see and examine, on a large scale, that with which the institute's shops have afforded him familiarity in an elementary and limited degree.

The course includes work with metal lathes, planers, drill press, milling machine; also work in carpentry, wood turning, vise work, blacksmithing, molding, steam fitting. The iron lathes, planers and miller are all in continual use, the length of the courses on these machines being divided up equally among the students of the class. Much time is devoted to pattern making. The course has of late been much improved, the students being furnished with complete patterns as models, as well as drawing of parts that they are required to make, together with complete stock pieces for making the same.

Each student when assigned to the pattern making course has already executed molding, wood turning and carpenter work; he therefore, has a knowledge of how a pattern should be made, as well as skill in wood turning, and in the use of pattern making tools. In order that work of this course, which is regarded as the most valuable one to the future engineer, shall be as efficient as possible, the time devoted to it is made continuous by causing it to fall entirely in the two supplementary terms.

Nearly all the wood lathes during the preleminary terms are let for the use of the patternmakers.

Students work in pairs on the metal lathes, planers, drill press, miller, at steam fitting and blacksmithing, and in groups of four at mill-

wrighting, this arrangement having been found to give much better results than in working singly.

Part of the work that previous to this time has been done in the senior supplementary term has been incorporated in the shopwork course, viz: Tension of belting in transmitting different horse power; rate of flow of water under a constant head through different lengths of pipe, and through pipes containing globe valves, cocks and elbows; use of steam engine indicator in connection with a slide valve engine and model specially arranged to secure to the student a thorough knowledge of the exact signification of the several portions of an indicator card; determination of the maximum load that can be sustained by tension pieces of tool steel, machine steel, wrought iron, cast iron, and brass, that have been turned to a standard size during the metal lathe course; elasticity of a pine beam 32 feet long, supported at its ends and loaded at various points along its length.

All this experimental work occurs after the first regular term of the sophomore year, at which time the students have acquired sufficient knowledge to calculate the results from formulæ, as well as to derive them from experiment. In the molding course the cupola is used as often as a sufficient number of molds are prepared to consume an entire charge of metal. With six students in the foundry casting occurs every second day.

The time devoted to shop-work by each student is distributed as follows:

Metal lathe,	225	hours.	Carpenter,	25	hours.
Pattern-making,	100	"	Brass turning,	20	"
Metal planer,	65	"	Steam fitting,	16	"
Vise work,	40	"	Steam boilers,	16	"
Molding,	40	"	Metal testing,	8	"
Wood-turning,	40	"	Elasticity of pine beam,	8	"
Blacksmithing,	40	"	Flow of water though pipes,	8	"
Miller,	32	"	Friction of belting,	8	"
Drill press,	24	"	Indicator cards,	8	"
Millwrighting,	24	"			

A graduating exercise in shop-work is now being put into operation, and consists of a detailed analysis of the cost of manufacturing a given number of some large machine, a working drawing of which is supplied the student. The steps involved in the execution of the exercise are the following:

1. Under the advice of skilled professional estimators, the kinds and sizes of machine tools required, and the time each tool would be used on each part of the machine to be built, are determined and entered on a blank form.

2. The list of machine tools necessary being determined, the cost of pulleys, belting, shafting and floor space are determined and tabulated

3. A form giving apparatus for motive power, etc., is then filled out, care being taken that the student is brought into contact with

reliable practicable advice in determining upon those details of outfit which cannot be definitely settled without personal experience.

4. From the contents of the last two forms, the size and arrangement of building will be determined; and the cost of the necessary building will be obtained by the student from a contractor who is engaged to supply such information when called upon.

5. Estimate of the cost of stock and running expenses will then be made, and an estimate of profits calculated.

A course of experimental mechanics given to the senior class during the supplementary term, and during a portion of the regular terms, is intended to be supplementary to the work of the third year in analytical and applied mechanics, resistance of materials and heat, as well as preparatory to the study of the steam engine, pursued during the regular terms of the fourth year.

The interest manifested in these exercises during the three years in which they have been introduced has stimulated the department to make systematic arrangements for their continuance and for more thorough instruction in the execution of the experimental tasks. It is arranged under eight groups, and each group is capable of affording three tasks, each of which students, working in pairs, can perform in one day of eight hours. Consequently, provision is made for forty-eight students as a maximum. The programme of operations is as follows:

During the months of July and August a party of assistants rehearses the exercises, so that no time need be lost in preparations during September. The same assistants take charge of a group of exercises during the supplementary term, and aid students to secure, without loss of time, the data belonging to experiments. As soon as the data of any one experiment is secured, the students report to the chief instructor, who directs such calculations as are necessary to deduce from the observed data the desired conclusions, after which the next exercise in regular order is assigned. Blanks for the data to be observed and for the results to be deduced are in readiness, so that the success of each task within the specified time may be assured.

The exercises in experimental mechanics, as arranged for the class of '84, included: breaking strength of metals; elasticity tests, including springs; valve settings; injector test; pump test; flow of water; flow of steam; boiler test; dynamo test; Buckeye engine test; analysis of chimney gases; driving power of belts.

Students perform an experiment and collect data with assistant instructor, and work up results and deductions with head of department. For each exercise one day is allowed for performing the experiment, and one day for working up data.

In view of the rapid developments of electrical science, and the close relations existing between many of the new applications of electricity and the work of the mechanical engineer, it has been judged

advisable to extend the regular course of the institute somewhat in this direction.

The fact that a large number of our present graduates hold prominent and responsible positions in the electrical companies throughout the country sufficiently proves that our course, as heretofore carried out, is well adapted to prepare those pursuing it for the profession of the electrical engineer, who must manifestly be first of all a mechanical engineer, and on this foundation build a certain amount of knowledge and experience in the special theory and practice of electric applications.

It is believed that by the addition to our former general instruction in electric science of a special department of applied electricity as a part of our regular course, the actual requirements of the profession will be best met.

In this department, which has now been in successful operation for two years, the theoretical knowledge acquired in our previous regular course has been supplemented by systematic laboratory instruction; in the management and care of batteries, galvanometers, rheostats, electrometers, condensers, etc.; in the measurement of resistances of wires, batteries, insulation, resistance and capacity of cables, electromotive force, etc. These and other experiments have been made sufficiently numerous and varied to familiarize the student with electrical terms, as potential, electromotive force, resistance, etc.; to give him a realizing sense of the various electrical magnitudes, as volts, ohm, ampère, etc., and to point out the quantitative relations of these units to the ordinary mechanical ones.

Special attention has been given to problems in connection with dynamo machines, such as the measurement of powerful currents, determinations of efficiency in generators and in electric motors, photometry of arc and incandescent lamps, consumption of energy in generator, conductors and lamps, dimensions of wires for various currents, etc.

For reasons above explained, it has been determined, after careful consideration, *not* to establish a special course in electrical engineering. A competent electrical engineer needs to be a competent mechanical engineer, and nothing taught in our fall course is unnecessary for the electrical engineer. To quote the words of the president of one of the largest electrical companies in the country, "An electrical engineer must be 90 per cent. mechanical, 10 per cent. electrical."

There is also an academic and preparatory department of the Stevens Institute of Technology. Graduation in the school secures admission into the institute. It is designed to meet the wants of youth preparing for the Stevens Institute and similar scientific and technical schools. But the school does not confine its studies to those required for admission into scientific schools. It embraces, also, in its English and classical courses of study all the branches pursued by students preparing for college or business.

3. Montclair Public Schools.

At a school meeting, held on May 23, 1881, a committee was appointed to investigate the subject of industrial or technical schools and to report at the next annual meeting. On May 22, 1882, after hearing the report of the committee, the trustees were authorized to give opportunity to the pupils of the grammar school, from twelve to fourteen years of age, to learn the proper use of wood-working tools, and $1,000 was appropriated for the purpose.

Accordingly, a competent instructor was secured, a room in the school building was fitted up with carpenters' benches, tool racks, tool boxes and twenty-five sets each of carpenters' and carvers' tools; the tools, benches and fitting costing about $350.

On October 1, 1882, the school was opened. The second and third grade grammar classes (ages from eleven to fourteen) were selected. A course of work was laid out. When it was possible to find anything written on the subject it was purchased and used as text book. While the boys were in the work shop, the girls of the same classes, under the guidance of their regular teachers, received lessons in needlework, embroidery and plain sewing. They designed and drew patterns, then transferred the same to goods. After this they worked out the patterns with colored woolens or silks.

The average attendance each year in the carpenter shop has been about fifty and in the sewing classes about forty pupils. The time devoted to the work has been one hour twice a week, in school hours. Arrangements were made so that the usual school studies were not interfered with. At the close of the year the pupils who have attended the industrial school have passed satisfactory examinations in their regular school studies and maintained their standing in their respective classes. They appeared not to have lost any ground, but rather gained.

The expenses for starting and carrying on of this work for the several years have been as follows:

First year,	$725 86
Second year,	599 34
Third year,	528 51
Fourth year,	681 19

The teachers' reports for the school year, ending July 1, 1886, are as follows:

Carpentry class, average daily attendance,	30
Carving class, average daily attendance,	26

Pupils draw their own designs on paper or on blackboard before beginning work. Boys in carpentry class have finished the thirty lessons in the course laid out, making altogether one hundred and twenty different pieces. Boys in carving class have had practice in panel

work; have made wall brackets, book racks, ink stands, card racks, picture frames, etc.; in all seventy pieces.

Boys show great diversity of talent, some becoming in a little time quite expert in tool handling, while others find it much more difficult. They show much enthusiasm and love for the work, many being inclined to visit the shop during play hours to work. Rigid discipline is maintained at all times, but the teacher has scarcely any trouble or annoyance. Each boy has a particular place assigned to him and always uses the same set of tools and is held responsible for keeping the tools in order and for returning them to their proper places at the close of the lesson.

COURSE OF INSTRUCTION IN CARPENTRY.

Lesson (1) use of hammer, vice, the rule, tri-square; (2) use of hammer in driving nails and spikes; (3 and 4) use of plane; (5) use of jointer; (6) use of chalk line and rule; (7) use of smoothing plane; (8) use of saw; (9) use of rip saw; (10 and 11) use of marking gauge; (12) use of bit and brace; (13) practice on lessons 9 and 12; (14) striking out and boring for mortise; (15) use of mallet and mortising chisel; (16) use of paring chisel; (17) planing to gauge; (18) making square frames from rough boards; (19) use of brad awl and screw driver; (20) driving nails horizontally; (21) planing boards out of wind; (22) use of knife for accurate marking; (23) making dovetails; (24) sharpening tools; (25 and 26) make square frame with locked joints; (27 and 28) make square frame, mortised corners; (29 and 30) make square frame with mitred corners; (34) preparing stock, sawing, planing, jointing; (32) striking out stock for different portions of a box; (33) halving sides and fitting ends; (34) putting parts together; (35) smoothing surfaces; (36) fitting lid to box; (37) fitting butts; (38) fitting lock; (39 and 40) special instruction in sharpening tools.

4. Newark Technical School.

Through the zeal and interest of the Newark board of trade a bill authorizing the establishment of technical schools was presented to the Legislature during the session of 1881 and passed, whereby the State appropriated from three to five thousand dollars annually, provided the citizens raise a like sum. By earnest and persistent effort the board of trade succeeded in securing an annual subscription of five thousand dollars by the citizens for five years, making ten thousand dollars per annum for the support of the school.

The entire control of these schools is vested in a board of trustees, "which shall consist of the Governor, *ex-officio*, who shall be president thereof, two persons selected by the State Board of Education, two by the citizens and associations contributing, two by the board of education, school committee, or other like body, of the locality where such school is established, and one by the common council, township committee or other governing body thereof, if such city, town or township shall contribute to the maintenance of such school."

The trustees received no compensation, but the expenses necessarily incurred by them in the discharge of their duties are paid out of the school fund of the State.

The object of all schools established under this act of the Legisla-

ture is the "training and education of pupils in industrial pursuits (including agriculture), so as to enable them to perfect themselves in the several branches of industry which require technical instruction."

The Newark school opened February 9, 1885.

As stated by the director, "It is not a school for teaching trades; it is not a school of manual training The classes of men the technical school is designed to reach are abnormally developed, it might be said, in the line of manual training, and it is the mental training which is necessary to round out the complete man. The latter the technical school designs to give. No attempt is made to graduate superintendents, engineers, or experts of any kind, that being outside of the plan of the management. The wish and expectation is that when the students have completed their course they will be better workmen than when they commenced."

From the character of the examination papers handed in at the entrance examination it was evident that a large number would avail themselves of the advantages offered by the school if they could pass the entrance examination. A preparatory class was therefore established, requiring no examination for admission. In this class instruction is given in arithmetic, and at the end of the year an examination is required which corresponds to the entrance examination.

In accordance with this recommendation, seventy-seven applicants were admitted to a preparatory class January 18, 1886, varying in age from sixteen to thirty-one years. At the close of the year, fifty-one of this number were in attendance.

ADMISSION.

An examination for admission is required more for the sake of finding out what the applicants know than to admit only a favored few. The management find this necessary in order to ascertain the kind of material they have to work with.

The requirements for admission are as follows:

Applicants for admission must be at least sixteen years of age, of good moral character, and residents of Newark.

They must pass a satisfactory examination in arithmetic, geography, history and English composition, to enter the first-year class.

Certificates of graduation from any grammar school in Newark are accepted as the requisite qualification for admission.

Applicants who have not graduated at a grammar school must pass an examination in the above studies.

No applicants are received who are attending other schools.

Applicants who are not prepared to enter the first year class may enter the preparatory class without an examination at any time, and must be at least fifteen years of age.

The sessions of the school are held five evenings in the week, viz:

From Monday to Friday inclusive. The hours of each sessions are from 7:20 to 9:30.

In laying out a course of study for any class of pupils the ultimate object must be kept in view, even though it is reached in an indirect way, and where the object is the greatest good to the greatest number, individual desires and peculiarities of mental capacity cannot be given too much importance. The trustees of the technical school have wisely chosen not to attempt too much at the outset, and planned their course so as to embrace but few subjects. The few that have been selected are well calculated to train the mind in methods of deductive and inductive reasoning, which, taken together, complete the method of true thought.

The course of study requires four years and is arranged in the following departments:

DEPARTMENT OF SCIENCE.

(a) Physics, with applications.
(b) General and agricultural chemistry, with applications.

DEPARTMENT OF MATHEMATICS.

(a) Arithmetic.
(b) Algebra.
(c) Geometry (plane and solid).
(d) Trigonometry.
(e) Elementary mechanics.
(f) Principles and use of machinery and tools.

DEPARTMENT OF DRAWING.

(a) Free-hand.
(b) Model.
(c) Cast.
(d) Architectural.
(e) Mechanical.

"All students are obliged to study free-hand before mechanical drawing, it being considered essential that, in order to make a good mechanical drawing, a person should be able to make a fair sketch. For those who do not intend to be draughtsmen, the course in free-hand is of great advantage in enabling them to express ideas graphically to others, which can be better done by this means than by words.

Many applicants seem to have a decided aversion to taking this part of the course, especially if they have no taste or apparent talent in that direction, and do not expect to follow any mechanical pursuit. But there comes a time in the life of every man, no matter what his business is, when he wishes to express an idea to another, which can be better understood and in less time, if illustrated by a sketch than described in words.

The methods of instruction followed in the technical school do not differ materially from those pursued elsewhere. Mathematics is taught by demonstration at the blackboard and individual work at the desks. Physics and chemistry are taught by lecture, illustrated by experiments showing physical and chemical phenomena, suites of specimens showing raw materials and manufactured products in technical processes, and lantern views.

Drawing is taught the first year from the "flat" or copy. In the second year wooden models and plaster casts serve as subjects, the sketch being executed with crayon and stump, and without artificial aid. The collection of plaster casts is well selected, and includes half-size figures of Vensus de Milo, Apollo, Belvidere, Discobolus, the Dancing Faun, the Fighting Gladiator, the Dying Gladiator, busts of Ajax, Napoleon, Laocoon, Sabrina, Julius Cæsar, masks of King Agrippa, Bitellus and Augustus Cæsar, besides casts of hands, arms, feet, leaves, flowers and fruit. From these the student obtains a good idea of proportion by training the eye to sketch objects from any point of view and without measurement. Indirectly, these casts serve another purpose. The student cannot have these before him many times before he asks whom the figures represent. The majority of our students have never heard of the characters in mythology, and many of the historical personages represented by these, and often a new inspiration is developed, followed up by a search for information which would probably never have occurred to them otherwise, and which may lead to a considerable degree of literary culture."

In the third and fourth years the students are taught mechanical drawing, being at first required to make a drawing of some simple model, showing three different views, then a drawing of the parts of a machine, and finally the complete machine put together from data which they already have, and not from the machine itself. These drawings are all working drawings, and such as could be used in any shop.

RESULTS.

The results simply justify the establishment of the school. At its opening, in 1885, there were 109 students: in 1888, 255, 90 of whom were in the preparatory class.

The report of the director, for 1886, says:

"The progress which the students make is necessarily slow for two reasons:

"1st. The majority have been out of school a long time, their minds have become dulled by inaction, and they have never had any trained habits of thought.

"2d. But little time can be obtained for study outside of school hours, the majority of the students being at work ten hours a day.

"Occasionally enthusiastic workers in the same shop will get to-

gether during the dinner hour and devote a part of it to study. Employers are much gratified to see their employés, who are students of the technical school, get together at noon for a 'quiz.'

"In the course of conversations with employers, I have discussed the matter of their further interest in the school by forwarding to me applications for help when they wish to engage clerks, apprentices or journeymen, thus giving me the chance of filling such places with our students, should there be any whom I could recommend. It seems to be the general sentiment of the employers that if an arrangement of this kind could be carried out it would be of great service to them, as well as the students.

"The school exhibits a healthy growth and public interest in its success seems to be increasing."

5. Orange.

"The sum of $1,000 was appropriated by the common council in April (or May), 1887, for the establishment of manual training in our public schools; and an additional sum of $1,000 was received from the State, in accordance with an act passed in the New Jersey Legislature on April 28, 1887.

"We have started this month with sewing, paper weaving and clay molding, and kindergarten methods in general, in the primary classes. The industrial drawing, including original designs, working drawings, etc., has been in the schools for some years, and is continued on the same basis. The sewing has been introduced in all the grades, including high school. It is probable that domestic economy, including lessons in simple cooking, will be introduced also, in the girls' upper high school classes, in the course of a few months. It is intended to give simple lessons in carpentry to boys of the grammar and high school classes, as soon as a competent instructor can be secured, and a room fitted up. The room is already secured. The attitude of the public mind seems very favorable to the plan, and the interest of the pupils is undoubted. There are two special lady teachers, and they are assisted in the lessons by the regular class teachers. One lesson a week in drawing, and one lesson in sewing, paper weaving or clay work, of some thirty or thirty-five minutes each, are given in each class. With the exception of the drawing, most of the work has been so recently introduced that I cannot speak of results to any extent; but we are greatly pleased with the beginning. The industrial drawing which was introduced some nine years ago, has been a very successful feature of our course.

"Very truly yours,

(Signed) "U. W. CUTTS, *Superintendent.*"

6. Vineland

The following very interesting account of Manual Training in the Vineland Schools was kindly furnished to the Commission by the Secretary of the school board, Mr. W. McGeorge, Jr.:

"*October 1st, 1888.*

"* * * * I gladly send you an account of what we are doing, why we introduced it, how we are trying to do it—the effect upon our schools, what aid is afforded by the State, how received by the public, etc., etc.

"It is well to understand in the first place that our district is the smallest one undertaking this work, so far as I know.

"Our school census calls for about 1.100 children from five to eighteen. The school buildings are one mile apart (seven of them) with the high school in the center, of six rooms.

"In 1875 at our annual school meeting the subject of industrial education, manual training (neither of which terms is the proper one, I prefer creative and constructive training), was casually discussed. At once the trustees began to investigate this work. In 1876 by an almost unanimous vote of the school meeting the trustees were instructed to prepare plans for its introduction and report at next meeting. A self-constituted committee of five gentlemen, all theorists, took the matter into their hands hoping to force the trustees to adopt their views. Some good work was done by them in the way of newspaper articles and the holding of two public meetings, which served to create a strong public sentiment, and thus pave the way for the trustees to carry out their plans.

"Our plan was to begin in a small way and at small cost to introduce such work as had been tried and successfully engrafted upon the public school system.

"In 1887 we presented our plans and asked for $500. It was voted without an opposing vote in a gathering of 387 citizens.

"We recognized that drawing was the basis or foundation, that sewing presented many valuable points. To do this we must have two specialists, and our $500 would not obtain *one*. We knew this when we asked for this amount, but wanted the money for material.

"We sought for a man who could act as principal and train our seventeen teachers so that they could teach the children in their schools. We found a man of the right stamp, and in June, 1887, opened a summer training school for teachers with an tendance of 45, and here the year's work was taught.

"The drawing is divided into ten steps:

"1. Begin with splints, making designs in straight lines; draw these designs on slates; then paper is furnished them, 14x11, and these same designs are drawn with pencil—no ruler, no rubber.

"2. Curved lines. Waxed thread or string make designs, and proceed as above,
"3. Copying from flat,
"4. Copying from object,

} no rulers, no rubbers.

"5. Begin mechanical drawing with instruments, etc., etc.

"Each pupil works independently. As soon as a step is completed and his paper accepted, it is sent to the principal and he keeps it. returning for it a certificate stating that the first step is completed. At least two lessons each week are given; but drawing can be engaged in at any time when a pupil is not otherwise engaged. All must draw.

"At our training school, June, 1888, lessons in clay modelling were given and will be introduced this year. Ten lessons in carpentry and several lessons in budding and grafting.

"By our State law any city voting $5,000 receives a like amount, and $1,000 was formerly given to small districts raising $1,000. This was later repealed making it $500.

"For the $500 voted by our district we received $500 from the State. Our taxpayers voted the same sum this year and willingly, showing that public sentiment favors the work. An exhibition of work done was held in March last and for two days hundreds of people examined the work.

"It is impossible for me to tell you how this creative and constructive training enters into other school work. Our teachers have made some of the handsomest charts, maps and pieces of school apparatus that I ever saw. We are not trying to teach trades, but we are trying to train the hand and eye. Penmanship properly belongs to this branch of work and has been added to it by us. Samples of work are at your disposal."

XVI. NEW YORK.

1. Albany High School.

A special committee appointed to investigate and report as to the advisability of introducing manual training into the public schools of Albany, recommended and the board adopted the following resolutions in October, 1887:

"*Resolved*, That it is expedient and advisable that manual training be added as a part of the course of instruction in our public schools.

"*Resolved*, That for the purpose of giving the new system a fair trial in the most economical manner possible, one of the rooms in the basement of the high school building be fitted up as a wood-working shop; that a competent instructor be employed to teach the boys in attendance at the high school in the proper use of wood working tools for a period of one year, the total cost not exceeding $1,500."

Pursuant to these resolutions the appropriation was duly made, the workshop fitted up, and in January, 1888, the classes were organized and the course opened.

The shop was furnished with twelve double work benches, giving ample space for classes, or divisions, of twenty-four boys each. Twenty-four kits of tools were provided, each consisting of the following:

1 wooden jack-plane,
1 Bailey iron fore-plane,
1 Bailey block-plane,
1 try square,
1 back saw,
1 marking gauge,
1 mortice gauge,
1 sliding T level,
1 screw driver,
1 pair winged dividers,
5 auger bits, $\frac{1}{4}$ to $\frac{5}{8}$ in.,
2 gauges, $1\frac{1}{4}$ and $\frac{3}{4}$ in.,
5 socket chisels, $\frac{1}{4}$ to $1\frac{1}{2}$ in.,
1 oil stone,
1 oil can,
1 hammer,
1 two-foot rule,
1 brace,
1 mallet,
1 cutter board,
1 duster.

"The following tools for general use were also furnished: counter sink, brad-awls, files, gimlet bits, four cross-cut saws, four rip-saws, one set of numbers and letters to mark and distinguish each pupil's work, one dozen iron hand clamps, brass stencil to mark aprons and hooks, six saw benches, a grindstone and a saw clamp.

"A lavatory of twelve basins and ample toweling permits each division to wash and dry hands in a moment, while each pupil provides

himself with a long work-apron to protect his clothing while at the bench.

"The cost of fitting and furnishing the shop was as follows:

"Twelve double work-benches	$156 00
Tools	251 15
Materials	14 41
Lavatory	140 10
Carpenter and painting bills	23 00
	$584 66

"The special teacher is paid $800 a year. It is estimated that materials, tools and supplies of all kinds will not cost more than $200 a year, so that the running expenses of this shop, giving instruction to 250 boys, will be about $1,000 a year. It is a noteworthy fact that in five months the breakage amounted to just twenty-four cents. A more extended plant reaching out into metal working, forging, lathe-work, molding and similar lines, will require additional expenditure.

"The shop was opened for class work in Februrry. The boys of the first and second years were required to join in this work, but those of the two upper classes were permitted to volunteer. Much to the surprise of the teachers, every boy in the school announced his desire to take the new course, and before many weeks had elapsed the senior boys, conscious that their time was limited to the few weeks of school left before their graduation, formed a special class to take leslons after school hours and on Saturdays, thus giving the strongest evidence of their high appreciation of the chance offered them of getting even a brief course in manual training.

"The course of procedure in instruction is briefly this: The drawing teacher exhibits an object to the class; the pupils make a working drawing from the object, carry the latter to the shop and from it reproduce the object in wood. Of course this is preceded by a sufficient number of lessons in the use of tools to enable the pupils to work readily and intelligently. Principles of construction are taught, as well as the most general use of tools. Nothing is made for use or for sale. Some specimens of work are kept to illustrate the work of the shop; the rest are either used over in the preliminary course in the use of tools, or are broken up and destroyed.

"From our brief experience we believe that it is established that manual training is legitimate educational work in our schools; that the tendency is to keep boys longer in school; that its effect is to round out the development of the pupil; that it promotes good order and discipline; that it has a moral force, and that it dignifies manual labor by removing false notions of degradations."

The report of the principal of the high school states:

"The most signal departure of the year was the establishment of

the manual training department. On the first of February, 1888, the large, well lighted play-room of the boys' gymnasium was ready, with its twenty-four well-equipped benches, to receive the first class in manual training. Work in this department was required of all the boys in the two lower classes, but was made voluntary in the two upper classes, in order that the experiment might not at the outset be complicated by any opposition or antagonism from those whom it was established to benefit. The result was that within one week almost every boy of the entire two hundred was enrolled in one of the manual divisions. By a careful adjustment of our programme of daily recitations, I was able to give to each boy two recitation hours per week at the bench without interference with other recitations. By this arrangement also every bench was occupied almost every available hour of the week.

"I think no more time could profitably be devoted to this branch than is now given, without detriment to other departments. Indeed, few subjects taught in the school receive more than the equivalent of two hours per week during the entire four years. I believe the board has adopted the true policy in this matter—not to turn our high school into a trades' school, but to add (what the term signifies) hand-training to that of mind-training. As certain lines of study have been found best fitted for mental training, so the line of work selected for this new department seems best fitted to develop manual skill.

"Of course the whole subject of manual training as related to our public schools is still in its infancy, but I hope to see it so far extended as to include instruction to the girls as well as to the boys. A *beginning* could certainly be made with very little expense. Should it be deemed advisable to add instruction in metal work to that in wood work for the boys, we have a room in the building that could easily be arranged for the purpose."

The following is a partial schedule of the work thus far laid out for this department:

No. 1. Hammer and planes.
2. Planing and sawing.
3. Housing or gaining out.
4. Housing or gaining angles.
5. Housing or gaining angles.
6. Housing or gaining angles.
7. Boring square, perpendicular and horizontal.
8. Boring angles.
9. Square butt-joint, nailing exercise.
10. Square butt-joint, toe nailing exercise.
11. Square butt-joint, housed and glued.
12. Square butt boxed and glued.
13. Halving at corners, nailed and glued.
14. Halving at corners and glued.
15. Halving at centers and glued.
16. Slip mortise and tenon.
17. Half blind, slip mortise and tenon, glued.

18. Mortise and tenon.
19. Blind mortise and tenon.
20. Corner mortise and tenon.
21. Double slip-mortise and tenon.
22. Double mortise and tenon.
23. Miter square edge nailed and glued.
24. Miter square flat nailed and glued.
25. Half miter and half square.
26. Half miter and half square, slip-mortise and tenon.
27. Half dovetail corner.
28. Half dovetail center.
29. Half dovetail and half square.
30. Dovetail, one tenon.
31. Dovetail, one tenon reverse.
32. Dovetail butt-joint.
33. Dovetail brace-joint.
34. Dovetail two tenons.
35. Dovetail three tenons.
36. Dovetail three tenons and halved.
37. Dovetail three tenons half-blind.
38. Dovetail three tenons half-blind.
39. Double dovetailing two tenons.
40. Double dovetailing two tenons half-blind.
41. Double dovetailing two tenons blind.
42. Doweling square butt.
43. Doweling square butt halved.
44. Doweling square butt blind.
45. Kerfing and bending.
46. Splicing and scarfing.

2. Pratt Institute.

The Pratt Institute was established after many years' study on the part of its founder, Mr. Charles Pratt, of Brooklyn.

Land was purchased in 1884, and the construction of buildings carried on through 1887. May 19, 1887, the charter was granted with power to confer degrees.

Its aims and methods are thus set forth in a circular of information issued in 1888: "Its object is to promote manual and industrial education, and to supplement this latter by advanced work in science and art.

It is now generally recognized that manual training is an important and necessary adjunct to the education of the schools, and that mind and eye and hand must together be trained in order to secure symmetrical development. Manual training aims at the broadest, most liberal education. While developing and strengthening the physical powers, it also renders more active and acute the intellectual faculties, thus enabling the pupil to acquire with greater readiness, and to use more advantageously, the literary education which should go hand in hand with the manual.

The need of manual training as a developing power is scarcely less than that of industrial education—such education as shall best enable

men and women to earn their own living by applied knowledge and the skilful use of their hands in the various productive industries. Accordingly, the institute seeks to provide facilities by which those wishing to engage in mechanical or artistic pursuits may acquire a thorough theoretic and practical knowledge thereof, or may perfect themselves in that occupation in which they are already engaged.

AIMS.

The two-fold aim of the institute is based on an appreciation of the dignity as well as the value of intelligent handicraft and skilled manual labor. It endeavors to give opportunities for complete and harmonious education, seeking at the same time to establish a system of instruction whereby habits of thinking may be inculcated, to develop those qualities which produce a spirit of self-reliance, and to teach that personal character is of greater consequence than material productions.

It offers its advantages to those only who propose to do their own part earnestly and well. Its aim is to aid those who are willing to aid themselves. Its classes, workshops, library, reading room and museum are for this purpose, and while tuition is required, yet it will be the endeavor to make possible by some means consistent with self-helpfulness and self-respect the admission of every worthy applicant.

The work of the institute is divided into departments, with a faculty organization, and the best talent obtainable will be placed in charge of each department.

It should be remembered that the institute has but just begun the work which it hopes to accomplish. The comprehensive nature of its buildings and appliances, the complimentary notices of the press, the patronage in so short a time of its more than five hundred students, should mislead no one into expecting more than can in the nature of things be realized. Many departments of perhaps equal importance with those already in progress have not been attempted; some of those now in operation are by no means complete. A beginning has been made, and, as is believed, in such a direction, that a natural and constant growth may reasonably be expected.

ART AND DESIGN.

Drawing is fundamental; it is the basis of all the constructive industries, all pictorial art and decorative design. It is the language by which a true idea of the form, the appearance, and the decoration of an object is conveyed from one person to another. It is the one universal language, and its importance to the designer and artisan is only comparable with reading and writing. Its applications are various and almost innumerable; but the subject, considered as a whole, may

be regarded as embracing three divisions, which include all the constructive, representative, and decorative arts, namely:

Construction.—Drawing as applied in industrial construction and the making of objects.

Representation.—Drawing as applied in representing the appearance of objects and of nature.

Decoration.—Drawing as applied in ornamentation.

The purpose of this department is to give thorough and systematic training in each of these divisions, which may be specialized under the heads of free hand, mechanical and architectural drawing, color, clay-modeling, design, wood-carving, etc.

COURSES OF STUDY.

Each course of study in this school is divided into three grades, ten acceptable studies or drawings being required in each.

Grade A of the general course in free-hand drawing is as follows:

1. Blocking in from casts, several drawings.
2. Appearance of cylindrical and rectangular objects.
3. Group of objects.
4. Corner of a room, building or miscellaneous group.

5, 6, 7. Studies in light and shade from casts and still life.

8. Harmony of color.
9. Historic ornament.
10. Principles of ornament and applied design.

Grade B includes work in design, blocking in and shading the head and figure from casts, drawings of drapery, and studies in color from still life.

Grade C will embrace advanced work from the antique, painting, and studies from life.

Thorough knowledge of free-hand drawing will be insisted upon before pupils will be admitted to advanced classes, as it is absolutely indispensable to good work. Students will not be allowed to omit any part of a course of study unless they can pass satisfactory examinations. Upon completing Grade A of the general course, those showing special ability in any direction will be advised as to their future work.

The special courses in design, architectural and mechanical drawing are graded in a way similar to that of the general art course, and pupils may enter any of these according to individual ability or fitness.

All students must attend lectures on perspective, historic, ornament, harmony of color, design, etc., according to course of stndy, and must take full notes.

Applicants must give evidence of a certain amount of ability in the line of work they wish to pursue in order to gain admittance to the school, and must pass an examination upon the work of one grade before entering another.

The free-hand, architectural and mechanical drawing is of the most practical and systematic character, showing a constant growth and development into the three fundamental divisions of drawing.

Evening classes have also been organized and are "intended to meet the needs of a large class of people, who, although employed during the day, yet desire to gain a thorough knowledge of drawing, realizing that it lies at the foundation of all industrial pursuits.

The rooms are admirably arranged for evening work, and, being lighted by electricity, students can work with as much comfort in the evening as during the day."

The design of the school is to make each course of study so thorough that pupils of aptitude and perseverance, who successfully complete the work of any department, may possess such information in theory and practice as may be made of practical use. To this end normal classes for those wishing to study drawing with the idea of becoming teachers, classes in clay-modeling, wood-carving, etc., will be organized as applications are received, and each of the other courses in both the day and evening classes will be developed to the fullest possible extent.

The first class in the "School of Art and Design," organized in October, 1887, numbered twelve—in March "the whole enrolment for day classes was 133 and for evening classes 174, a total of 307.

MANUAL TRAINING.

Instruction in the department of mechanic arts is designed for three distinct classes of pupils: First, members of the regular three years' course, who, in connection with their literary work, will be given courses in wood and iron work—joinery, patternmaking, wood-turning, molding, casting, forging, etc. Second, pupils in other schools, who wish to supplement their studies with some kind of manual work. Third, those who are employed during the day, but wish to join evening classes in order to learn some mechanic trade, or to perfect themselves in the trade in which they are engaged.

Although much of the work of the institute is designed to be supplemental to that of other institutions, yet it has been thought wise to establish for boys, a full three years' course, to include free-hand and mechanical drawing, and shop-practice, at the same time giving opportunity for the studies of a thorough English education.

In outline, the course is as follows: An average of one hour per day of free-hand and mechanical drawing, two hours of shop-practice—tool and machine work in wood and metals—and three hours daily in the class room, to be devoted to mathematics—algebra, geometry and trigonometry; science—physiology, physics, chemistry, etc.; English—history, literature, political science, etc.

Applicants for admission to this course are required to pass exami-

nation in arithmetic (entire), geography, United States history, grammar and composition.

BUILDINGS.

The buildings of this department cover a ground space about 250 x 100 feet, are constructed of brick with blue stone trimmings, and vary from one to four stories in height. A bridge from the third story connects them with the second story of the main building.

In the basement is the boiler room, containing two boilers of 100 horse power each, which furnish steam for heating the entire group of buildings, and supply power for the engines, elevators, electric lights, fire, pumps, etc.

In the engine room adjoining is a Harris Corliss engine of 40 horse power to operate the machinery of the shops, and an Armington & Sims engine to run the dynamo, which has a capacity of 500 sixteen-candle power incandescent lamps. The engines, the generation of steam and electricity, and their connections with the buildings, have been so arranged as to offer a means of instruction to the pupils. The remainder of the basement is used for storage, etc.

On the south side of the first floor of these buildings is the forge room, 73 x 29 feet and 18 feet high, provided with ventilating skylights. The room is planned to accommodate thirty-six pupils, and forges, anvils, etc., are provided for that number. A system of pipes furnishes blast to the forges, and an exhaust fan serves to carry away fumes and smoke.

Adjoining this room on the north is the foundry, 66 x 29 feet, with an 18-foot ceiling. Two large skylights are built in the roof, giving good light and abundant ventilation. It will be furnished with a cupola of sufficient size to supply the shop with castings.

In the rear of the forge, foundry and engine rooms are large accommodations for lockers, wash-rooms, store-rooms, etc.

At the north end of the first floor is a room 92 x 37 feet designed for metal-working. It is fitted with sufficient bench room for forty-eight vises, also a number of engine and drilling lathes for iron work, and a complete set of standard typical machines is contemplated.

The main wood-working room, at the north end of the second floor, is 92 x 37 feet, and is furnished with about 150 feet of wall bench, and thirty-six single benches, supplied with the latest and most improved tools. It contains a number wood-turning lathes, a large pattern-maker's lathe, buzz-planer, surfacer, etc.

The lumber and tool rooms are adjacent to this room.

It is intended that the third floor of this building shall be used for laboratories and class rooms, and the fourth for advanced work in metals, engraving.

North of the mechanic arts building is a building designed for the department of building trades. It is 103 x 95 feet, and is built with a clear story, the ceiling being about thirty feet high.

The work in this department was commenced February 20, 1888, with pupils in bricklaying, modeling, stone-carving and plumbing. Instruction is given three evenings of each week, from 7.30 to 9.30 o'clock.

METHODS.

In bricklaying, pupils are first taught to handle the trowel and spread mortar properly. They are then put to work upon eight-inch walls until they can carry the corners up plumb, and lay the courses level. Particular care is taken that the joints shall be thoroughly stuck and pointed. When the student can do this neatly and well he is taught the construction of arches, etc.

In stone-carving, pupils are drilled upon working out forms, illustrating the different styles of ornament in architecture. All are required to sketch designs and model them in clay before cutting them in stone. This course is followed in order to develop any talent which a pupil may have, and in order to produce carvers whose work shall be original and artistic.

In the plumbing section, benches completely equipped with tools have been provided for fifty-four pupils. The course of study includes the making of lead seams, all kinds of wiped joints and sand bends, drill in the working of sheet lead, in the erection of sewer pipes, etc. Special attention is given to the sanitary aspects of plumbing, and the course of instruction will be such as to insure an understanding, on the student's part, of the scientific principles of drainage, sewerage and ventilation, together with ability to make practical application of the same in the most thorough manner.

An important feature of the institute is its lecture courses. It is intended that these shall bear directly upon the work of the institute in all its phases, and shall thus include practical instruction upon those matters which pertain to right modes of living, the problems of political and social life, domestic economy, sanitary science, literary culture, ethics, etc. While many of these courses may be given as a part of the regular work of the institute to pupils only, yet many others will be so arranged as to meet the wants of those not otherwise connected with the institute, but who wish the opportunity to obtain systematic instruction upon subjects of interest and importance.

3. Cornell University.

April 27, 1865, the Legislature of New York incorporated the Cornell University in accordance with the National Land Grant Act of 1862. In connection with the university the "Sibley College of Mechanical Engineering and the Mechanic Arts" was founded and endowed in 1870.

This college is divided into three principal departments: That of

mechanical engineering, including a laboratory in which experimental work and investigations are conducted; a department of mechanic arts, or shop work; and a department of drawing and machine design.

REGULAR COURSE.

It is intended by the trustees of the university to be made not only a school of arts and trades, but a college of mechanical engineering also, in which schools of the mechanic arts and of the various branches of mechanical engineering shall be developed, as rapidly and extensively as the means placed at the disposal of the trustees of the university, and a demand for advanced and complete courses of instruction, shall allow.

ADMISSION.

Candidates for admission must be at least *sixteen* years of age, and must pass examination in English; geography, political and physical; physiology and hygiene; arithmetic, plane geometry, algebra.

In place of these examinations certain certificates or diplomas are received, as follows:

1. *Certificates* issued by the *Superintendent of Public Instruction* of the State of New York, and *diplomas* issued by those academies and high schools of the State of New York whose requirements for graduation have been approved by the faculty, and whose course of study requires physiology and plane geometry, are accepted in place of the examinations in all the subjects named above *except algebra.*

2. *Diplomas* issued by the *regents* to graduates from the high schools and academies of the State of New York, and diplomas issued by the State normal schools of the State of New York, are accepted in place of the examinations in all the subjects named above.

The fee for tuition is $25 a term.

Students taking work in Sibley College courses are charged $5 per term for materials and extra expenses.

I. DEPARTMENT OF MECHANICAL ENGINEERING.

The department of mechanical engineering is divided into two principal sections: That of theoretical engineering and that of experimental engineering, or the mechanical laboratory.

(1) *Section of Theoretical Engineering.*—The lecture-room course of instruction consists of the study, by text-book and lecture, of the materials used in mechanical engineering; the valuable qualities of these materials being exhibited in the mechanical laboratory by the use of the various kinds or testing machines, as well as by examination of specimens of all the most familiar grades, of which samples are seen in the cases of the museums and lecture rooms. The theory of strength of materials is here applied, and the effects of modifying conditions—such as variation of temperature, frequency and period of

strain, method of application of stress—are illustrated. This course of study is followed, or accompanied, by instruction in the science of pure mechanism or kinematics, which traces motions of connected parts, without reference to the causes of such motion, or to the work done, or the energy transmitted. This study is conducted largely in the drawing rooms, where the successive positions of moving parts can be laid down on paper. It is illustrated, in some directions, by the set of kinematic models known as the Reuleaux models, a complete collection of which is found in the museums of Sibley College.

The study of machine design succeeds that of pure mechanism, just described. This study also is largely conducted in the drawingrooms, and is directed by an instructor familiar, practically as well as theoretically, with the designing and proportioning of machinery.

The closing work of the course consists of the study, by text-book and lecture, of the theory of the steam engine and other motors. The last term of the regular four-year course is devoted largely to the preparation of a graduating thesis, in which the student is expected to exhibit something of the working power and the knowledge gained during his course. *A graduating piece* is demanded, also, of each student, both in the drawingroom and the workshop, which shall show proficiency in those departments.

(2) *Section of Experimental Engineering, or Mechanical Laboratory Instruction.*—The work in this department will be conducted by an instructor familiar with its apparatus and with the best methods of work, and who will plan a systematic course of instruction intended to give the student not only skill in the use of apparatus of exact measurement, but to teach him also the best methods of research, and to give him a good idea of the most effective methods of planning and of prosecuting investigations, with a view to securing fruitfulness of result with minimum expenditure of time and money.

II. DEPARTMENT OF MECHANIC ARTS, OR SHOPWORK.

The aim of the instruction in this, the department of practical mechanics and machine construction, is to make the student, as far as time will permit, acquainted with the most approved methods of construction of machinery.

(1) *Section of Woodworking and Patternmaking.*—This course begins with a series of exercises in woodwork, each of which is intended to give the student familiarity with a certain application of a certain tool; and the course of exercises, as a whole, is expected to enable the industrious, conscientious, and painstaking student easily and exactly to perform any ordinary operation familiar to the carpenter, the joiner, and the patternmaker. Time permitting, these prescribed exercises are followed by practice in making members of structures, joints, small complete structures, patterns, their core-

boxes, and other constructions in wood. Particular attention is paid to the details of patternmaking.

(2) *Section of Forging, Molding, and Foundry work.*—These courses are expected not only to give the student a knowledge of the methods of the blacksmith and the molder, but to teach him also how to use the tools and to give him that manual skill in the handling of tools which will permit him to enter the machine shop, and there quickly to acquire familiarity and skill in the manipulation of the metals, and in the management of both hand and machine tools, as used in the working of such metals.

(3) *Section of Iron working.*—The instruction in the machine shop, as in the foundry and the forge, is intended to be carried on in substantially the same manner as in the woodworking course, beginning by a series of graded exercises, which give the student familiarity with the tools of the craft and with the operations for the performance of which they are particularly designed, and concluding by practice in the construction of parts of machinery, and, time permitting, in the building of complete machines which may have a market value.

III. DEPARTMENT OF INDUSTRIAL DRAWING AND ART.

(1) *Section of Free-hand Drawing and Art.*—Instruction in this department begins with free-hand drawing, which is taught by means of lectures and general exercises from the blackboard from flat copies and from models. The work embraces a thorough training of the hand and eye in outline drawing, elementary perspective, model and object drawing, drawing from casts, and sketching from nature.

The course in free-hand drawing is followed by instruction in industrial art, in designating for textiles and ceramics, in modeling, and in other advanced studies introductory to the study of fine art.

(2) *Section of Mechanical Drawing.*—The course of instruction in mechanical drawing is progressive, from machine-sketching and geometrical drawing to designing of machinery and making complete working drawings.

The course begins with free-hand drawing, as above, and in the latter part of this work considerable time is expected to be given to the sketching of parts of machines and of trains of mechanism, and later of working machines. The use of drawing instruments is next taught, and after the student has acquired some knowledge of descriptive geometry and the allied branches, the methods of work in the drawing rooms of workshops and manufacturing establishments are learned. Line drawing, tracing and blue printing, the conventional colors, geometrical constructions, projections, and other important details of the draughtman's work are practiced until the student has acquired proficiency.

The advanced instruction given the upper classes includes the trac-

ing of curves and cams, the study of kinematics on the drawing boards, tracing the motions of detail mechanism and the kinematic relations of connected parts. This part of the work is accompanied by lecture room instruction and the study of the text-book, the instructors in the drawing rooms being assisted by the lecture room instructor, who is a specialist in this branch. The concluding part of the course embraces a similar method of teaching machine design, the lecture room and drawing room work being correlated in the same manner as in kinematics or mechanism. The course concludes, when time allows, by the designing of complete machines, as of the steam engine or other motor, or of some important special type of machine.

Industrial Art.—A four years' course of instruction in industrial art is arranged for students having a talent for such work, and desiring to devote their whole time to this subject. No degree is conferred, but a certificate of proficiency may be given at the end of the course.

The mechanical engineering course, in detail, is as follows (the figures after subjects indicate the number of hours per week):

Freshman Year.

Fall Term. French or German, 5; algebra, 5; rhetoric, 2; free-hand drawing, 3; shop-work, 2; drill, 2.

Winter Term. French or German, 5; trigonometry, 5; rhetoric, 2; free-hand drawing and machine sketching, 3; shop-work, 2.

Spring Term. French or German, 5; theory of equations, 2; projective geometry and conic sections, 3; instrumental drawing, 3; rhetoric, 2; drill, 2; shop-work, 2; drill, 2.

Sophomore Year.

Fall Term. Analytical geometry, 5; descriptive geometry, 3; experimental mechanics and heat, 3; chemistry, lectures, 4; shop-work, 3; drill, 2.

Winter Term. Differential calculus, 5; electricity and magnetism, 3; chemistry, lectures, 4; descriptive geometry, 3; shop-work, 3.

Spring Term. Integral calculus, 5; acoustics and optics, 3; descriptive geometry, 3; chemistry, laboratory, 4; shop-work, 3; drill, 2.

Junior Year.

Fall Term. Mechanics of engineering, 5; kinematics, 5; designing and drawing, 2; physical laboratory, 2; chemistry, laboratory, 4; shop-work, 2.

Winter Term. Mechanics of engineering, 5; materials of engineering and mechanical laboratory work, 6; physical laboratory, 2; designing and drawing, 2; shop-work. 3.

Spring Term. Mechanics of engineering, 5; physical laboratory, 2; mechanical laboratory, 2; designing and drawing, 2; machine design, 2; shop-work, 3.

Senior Year.

Fall Term. Steam engine and other motors, 5; physical laboratory, 2; mechanical laboratory, 2; designing and drawing, 3; machine design, 3; shop-work, 3.

Winter Term. Steam engine and motors, 5; physical laboratory, 2; mechanical laboratory, 2; machine design, 3; designing and drawing, 3; shop-work, 3; military science, 2.

Spring Term. Thesis, designing and drawing, mechanical laboratory investigations, shop-work (time divided optionally, but subject to approval of the head of the department*), 12; elective, 3 to 6.

Senior Year.

Fall Term. Physics, lectures and laboratory work (testing of instruments and determination of constants), 6; steam engine and other motors, 5; mechanical laboratory, 2; designing and drawing, 3; machine design, 3.

Winter Term. Physics, lectures and laboratory work (dynamo machines and electric motors, tests of efficiency), 6; steam engines and motors, 5; mechanical laboratory, 2; designing and drawing, 3; military science, 2.

Spring Term. Physics, lectures and laboratory work, photometry, efficiency tests of electric lamps, tests of telegraphic instruments, lines and cables, 5; thesis (laboratory work, reading, etc, in connection with preparation of thesis), 12.

COURSE IN INDUSTRIAL ART.

Freshman Year.

Fall Term. French or German, 5; algebra, 5; rhetoric, 2; outline drawing, 3; drill, 2.

Winter Term. French or German, 5; trigonometry, 5; rhetoric, 2; outline and ornamental drawing, 3.

Spring Term. Drawing, from casts and figures, 3; analytical geometry, 5; instrumental drawing, 4; botany, 3; theory of color, 1; drill, 2.

Sophomore Year.

Fall Term. Calculus, 5; descriptive geometry, 3; chemistry, 3; experimental mechanics and heat, 3; composition, 1; studies in anatomy, 1; drill, 2.

Winter Term. Cast and figure drawing, 4; electricity and magnetism, 3; chemistry, 3; elementary coloring, 1; principles of design, 3; descriptive geometry, 3.

Spring Term. Plant forms, 2; coloring, 3; modeling and potter's wheel, 3; acoustics and optics, 3; free-hand drawing, 3; descriptive geometry, 3; drill, 2.

Junior Year.

Fall Term. Æsthetics, 2; drawing, 4; molding and modeling, 4; geology, 3; physiology, 3; coloring and designing, 1.

Winter Term. History of fine arts, 1; coloring, 4; phychology, 3; descriptive astronomy, 3; drawing from casts, 4.

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*This term is devoted largely to the preparation of a thesis which must be approved by the director and by the committee on thesis. If not otherwise arranged-the student will take shopwork, laboratory work, and drawing, 3 each.

The freshman, sophomore, and junior years are identical with the course in mechanical engineering; in the senior year, laboratory work is increased, the time being taken from that devoted to shop-work.

Spring Term. Wood-working, 2; photography, 2; history of art, 2: building materials and construction, 3; logic, 3; drawing from nature, decoration and coloring, 4.

Senior Year.

Fall Term. Stereotomy, 3; English literature, 3; history of industrial arts, 2; modeling in clay, 2; wood-carving, 2; designing in color, 3.

Winter Term. History of art, 3; coloring from nature, 2; etching, 3; designing, 5; military science, 2.

Spring Term. Designing in form and color, 4; working stone, 2; painting from nature, 3; graduating work and thesis.

EQUIPMENT.

The mechanical laboratory, which is the department of demonstration and experimental research of Sibley College, and in which not only instruction but investigation is conducted, is located in the annex of Sibley College, in several rooms of good height, well lighted on all sides, and carefully fitted up for the purpose for which they are designed. It occupies the whole lower floor, a space of one hundred and fifty feet long, by forty feet wide. It is supplied with the apparatus of experimental work in the determination of the power and efficiency of the several motors, including steam engines, and the turbine driving the machinery of the establishment; with boiler-testing plant and instruments; and with a number of machines for testing lubricants and the strength of metals. Among these is the "autographic testing machine," which produces an autographic record of the results of the test of any metal which may be placed within its jaws, securing exact measures of the strength, the ductility, the elasticity, the resilience or shock-resisting power, the elastic limit, etc., of the material. Several steam engines and boilers, air and gas engines, several kinds of dynamometers, lubricant-testing machines, standard pressure-gauges, and other apparatus and instruments of precision employed by the engineer in such researches as he is called upon, in the course of his professional work, to make, are all collected here.

The museums and collections of this college are of exceptional extent, value, and interest.

The two principal rooms on the first floor of the main building are devoted to the purposes of a museum of illustrative apparatus, machinery, products of the manufacturing industries, and collections exhibiting processes and methods of manufacture, new inventions, the growth of standard forms of motors, and other collections of value in the courses of technical instruction given in the college. In the west museum are placed the Reuleaux collection of models of kinematic devices and movements, which is, so far as known, the only complete collection on this continent, and is one of the very few in the world. Besides these are the Schroeder and other models, exhibiting the forms and proportions of parts of machinery, the construction of steam engines and other machines, and methods of making connections. In the east museum are placed a large number of samples of machines constructed by the best makers, to illustrate their special forms and methods of manufacture. Among these are several beautifully-finished samples of steam pumps, "sectioned" to exhibit their internal construction and arrangement, steam-boiler injectors similarly divided, governors for steam engines, water-wheels, and other motors, devices for lubrication, shafting and pulleys, couplings, and other apparatus for the transmission of power, both by shafting and by wire-rope transmission. The lecture-rooms of the Sibley College, each being devoted to a specified line of instruction and list of subjects, are each supplied with a collection of materials, of drawings, and of models and machines, especially adapted to the wants of the lecturer in each subject. Thus, the lecture-room of the instructor in "Materials of Engineering" contains a fine collection of samples of all the metals in common use in the arts, with samples of ores and of special intermediate products, exhibiting the processes of reduction and

manufacture. Among these are specimens of the whole range of copper-tin and copper-zinc alloys, and of the "kalchoids" produced by their mixture, such as were the subjects of investigations made by the Committee on Alloys of the United States Board appointed by President Grant by authority of Congress, in the year 1875. The collection is supplemented by other alloys produced later by the director, and is one which has no known superior, and is perhaps unequaled. The course in machine design is illustrated by the standard forms of parts of machinery. The course of instruction in mechanical engineering is illustrated by a fine collection of steam engines of various well-known types, gas and vapor engines, water-wheels, and other motors, models and drawings of every standard or historical form of prime mover, of parts of machines, and of completed machinery.

The collections of the department of drawing include a large variety of studies of natural and conventional forms, shaded and in outline, geometrical models, casts and illustrations of historical ornament.

The workshops are supplied with every needed kind of machine or tool, including lathes, of our own and other makes, and hand and bench tools sufficient to meet the wants of over one hundred students of the first year, in woodworking; in the foundry and forge all needed tools for a class of eighty in the second year; in the machine shop, lathes from the best builders, and others made in the University shops, planes, drills, milling machines, and a great variety of special and hand-tools, which are sufficient to work a class of sixty or seventy of the third year, and fifty or sixty seniors.

The department of experimental engineering possesses experimental engines and boilers, and other motors, such as air and gas engines, and is well supplied with testing machines in considerable variety, as well as all the apparatus required, as indicators, dynamometers, etc., for determining the efficiency of engines. Each of the several rooms on the first floor of the Sibley College annex is a museum of apparatus.

4. Jamestown Public Schools.

The following account is taken from Superintendent Love's work, entitled "Industrial Education."

"After several years of consideration as to adopting manual training in the schools, in the fall of '74 it was determined to make a beginning by opening a printing office. A press, type and fixtures, costing $125, were purchased—money from the 'fund'—and set up in an unoccupied room on the fourth floor It was placed in charge of the commercial teacher, who, when a boy, had worked in a printing office. Two classes of boys and girls of four each were selected from the grammar and high schools to learn to set type. They were given two hours or more each week, during the school year.

"For two or three years it seemed impossible to add anything more. Accident, however, opened the closed door. One day, a boy was sent to my office as incorrigible. When he came in with the note from his teacher, seeing that he was very angry, I sent him on an errand. On his return I told him I wanted a certain article made; showed him the drawing I had made of it. He seemed greatly pleased; so I told him to make a good copy of the drawing, making each line twice as long. When finished I said:

"'Can you do this work if I give you one hour each day from school?'

" 'I am not a member of the school any more,' he replied with trembling lips.

" 'That is bad, but I think you can return if you desire.'

" 'I would like to return.'

" 'Then go down and handsomely apologize for your past misconduct; make good promises for the future, and you will get your seat again, I have no doubt. Please ask your teacher to come to the office a moment.' Arrangements were soon made and the work done, on the second trial, quite satisfactorily. Several other cases of disobedience, etc., were referred to me and similar employment was given. Some of them did their work at home and some at the janitor's bench, in his workroom in the basement.

"In this unlooked for way, a little furore was created among the teachers to have some boys set to work, good boys as well as bad, and the girls, too.

" Some were set collecting specimens of the different kinds of domestic woods and taught how to prepare them; others collected land and water snails. In the primary schools, little things were conjured up for the pupils to do. In one they were engaged in cutting and making pen-wipers of various patterns and with suitable ornamentations; in another, cutting and making picture scrap-books.

" All these these things made it more evident that something must be done towards making a permanent establishment of some of the industries in the schools. Gradually sewing was provided for the girls, and a work-bench for the boys. Pupils were selected because they were good scholars, or good for nothing, or any other good reason presented by the class teacher.

"For a year or more this bench has occupied the greater part of the day, each boy enjoying the privilege twice a week for about one-half the year. They thus learned the use of most of the carpenter's tools, beginning with the hammer.

" The board of education in the spring of '82 subscribed liberally, and assisted greatly in other ways to raise a fund with which a shop was built, large enough to accommodate four benches and three lathes, with a loft for storing away lumber, also to supply all the tools and fixtures to put in complete running order. This done, the shop was placed in charge of two young men, and under the general direction of the janitor (a good mechanic), one of them gave instruction to classes every school hour of the day.

" Since that time changes have been steadily made in every branch of the department, all tending to improve and enlarge the methods, increase the force of instructors, and add to the number of those receiving instruction. Three years ago, two wings were added to the high school building, and in the basement are two rooms, one of which is used for a sewing room and printing office, and the other for the shop. Those rooms are about 28 feet by 37 feet, are well lighted and pleas-

ant, and are supplied with all needed tools, material and instructors, and are kept open during all the school hours of the day, four days of the week."

"To-day, January 19, 1887, this much can be said of the department of manual training in Jamestown public schools. All the pupils in the first six grades, about 1,400 in number, are given lessons daily, or at least three or four times a week, in some kind of manual training. One hundred and twenty-five of the girls and sixty-five of the boys receive lessons in the sewing-room or shop at least twice or three times each week, and twenty boys and girls set type in the printing office one hour four days of the week."

The course of instruction in manual training in the different grades is as follows:

PRIMARY DEPARTMENT.

First Year—First Grade.

Writing, on the slate and blackboards; drawing, lines and angles on the slate; gymnastics, free and marching; industrial, block building, stringing straws, stringing beads and learning colors, tablet laying, paper folding.

Second Year—Second Grade.

Writing; drawing, lines and angles, and subjects on slate; gymnastics, free, musical and marching; industrial, stick laying, picture cutting, making scrap books, spool work, paper embroidery and braiding.

Third Year—Third Grade.

Writing, shorter course, No. 2; drawing, review work and inventive; gymnastics, free, musical and marching; industrial, perforated cardboard embroidery, review work, slat plaiting, mat weaving.

SECOND PRIMARY DEPARTMENT.

First Year—Fourth Grade.

Penmanship, tracing book, No. 3; drawing, free-hand, on slate and black-board; gymnastics, free exercise and marching; industrial, slat plaiting, advanced crocheting, chain stitch, paper folding advanced, perforated card-board embroidery advanced.

Second Year—Fifth Grade.

Penmanship, tracing book, No. 4; drawing, free-hand and inventive, on slate and black-board; gymnastics, free exercises and marching; industrial, sewing over and over, review work, crocheting, paper folding and mounting.

Third Year—Sixth Grade.

Penmanship, shorter course No. 5; drawing, primary drawing book No. 1; gymnastics, the same as the second year; industrial, hemming, review work, pease work, knitting, paper-flower making.

GRAMMAR DEPARTMENT.

Junior Grammar Class—Seventh Grade.

Penmanship; drawing, free-hand and industrial; physical culture, exercises in gymnasium; manual training for boys; to draw lines and lay off distances, use of the hammer, the saw, the plane; manual training for girls: plain sewing, running, gathering, stitching, overcasting, over and over sewing and hemming; printing, boys and girls, 1, learn the letters in the lower case; 2, also in the upper case; 3, to hold and handle the stick; 4, to set up and distribute words; 5, also sentences; 6, to set up and distribute copy.

Middle Grammar Class—Eighth Grade.

Penmanship; drawing, free-hand and industrial; physical culture, exercises in the gymnasium; manual training for boys, review the work of the last year; lessons in construction, boring, chiseling; manual training for girls, crocheting, knitting begun; printing for boys and girls, 7, to learn to correct proof; 8, to set up copy and distribute it on time; 9, to make up and lock forms.

Senior Grammar Class—Ninth Grade.

Penmanship; drawing; physical culture, exercises in the gymnasium; manual training for boys, review lessons of the last year, lessons in mitering, dovetailing, doweling; begin drawing and construction; manual training for girls, knitting advanced, mending, patching, darning, making button holes; printing, boys and girls, 10, run the press; 11, wash type and distribute form; 12, do job work given out.

ACADEMIC DEPARTMENT.

Tenth, Eleventh, Twelfth and Thirteenth Grades.

This work in manual training may be adapted to all high schools.

For Young Men.	*For Young Women.*
1. Drawing and construction.	1. Cutting.
2. The lathe.	2. The use of the sewing machine.
3. Finishing.	3. Embroidery.
4. Printing.	4. Cooking.
	5. Printing.

"It has cost much thought and experiment to determine what manual training is deemed appropriate for each grade. * * * The arrangement here given is imperfect in some of its features, and is not satisfactory in all respects; but still it is the best that could be made in view of the attitude of the public, and the means at hand to give manual training."

The following extracts from the annual report of the board of education for 1888 indicates the attitude of the public:

"The members of the board are fully convinced of the many benefits to be derived from manual training. They have aided the efforts of Superintendent Love in introducing the system into our schools and are in full sympathy with his plans. They have done all that they could do without overstepping the bounds of their authority. All is being done that can be done, until further power is conferred upon the board, either by State law or by local enactments.

"In view of the fact that hand training may be profitably entered upon early in the school life of the child, we have adopted a plan of giving the pupils in the district schools, comprising the first six grades, short daily or tri-weekly lessons in manual training, adapted in part from the kindergarten methods. It is inexpensive, works well and is considered by the teachers a valuable aid in promoting the intellectual development of their pupils."

Superintendent Love writes, September 28, 1888:

"There has never been any legislation in this city, on the subject of industrial education. I have always worked with the consent of the board, however. Public sentiment has always been favorable to

our plans in regard to it, and I think the patrons would be very unwilling to have it given up or crippled in any way.

"My teachers would, every one of the sixty-five, tell you that the results were entirely satisfactory, very beneficial, and that they would not like to teach without manual training."

5 The College of the City of New York.

The College of the City of New York, established in 1848, embraces four courses of study; a classical course and a scientific course, each extending over a period of five years; a mechanical course extending over a period of three years; and a post-graduate course of civil engineering extending through two years.

No applicant is admitted to the sub-freshman class unless he be fourteen years of age, a resident of the city of New York, and pass a satisfactory examination in writing, spelling, the English language, arithmetic, some elementary propositions in geometry, geography, the history of the United States and the elements of industrial drawing.

Any young man, a resident of the city, is received into any of the higher classes, provided he satisfactorily passes examination in the subjects already completed by the class to which he seeks admission.

Instruction is free; so is the use of text-books and apparatus; and there is no expense whatever to be borne by the students.

The mechanical course, in detail, is as follows:

FIRST YEAR.

	Lessons a week.
French, German or Spanish,	5
English language,	3
Mathematics,	3
Physics,	2
Drawing—free-hand and mechanical,	3
Workshop, instruction and practice, or commercial products,	4
	20

SECOND YEAR.

The same modern language as oefore,	5
English,	3
Mathmetics,	3
Chemistry,	2
Drawing,	3
Workshop or commercial products,	4
	20

THIRD YEAR.

A second modern language,	5
English,	3

Mathematics,	3
Physics and chemistry,	5
Workshop or history and political economy,	4
	20

Students pursuing this course, who wish to prepare themselves for mercantile business, may substitute the study of commercial products for mechanical instruction and practice in the workshop. Students who have completed the mechanical course may, upon passing a satisfactory examination, remain in the college and enter the junior class of the scientific course.

Students in the classical and scientific courses are admitted to the workshop after hours of recitation, $4\frac{1}{2}$ hours per week, so far as they can be accommodated; and provided, in the opinion of the faculty, this additional work does not impede their progress in the courses to which they belong.

THE WORKSHOP.

Connected with the college is a workshop in which instruction is given in the elements of mechanical manipulation. The course of workshop instruction extends over three years. In the first year the use of wood-working tools is taught. The student becomes acquainted with all the ordinary wood-turning tools, and learns to fashion wood exactly to any required form and dimensions; to make joints of all kinds; to veneer, finish and polish. In the second year the metal-working tools are used, and the arts of forging, chipping, filing, soldering, finishing and lacquering are learned. In the third year the working of metals is carried further; the use of the lathe in turning wood and metal is learned, the side rest and the engine lathe are introduced, and the use of these tools in the making of screws, gear-wheels and other parts of machinery is taught.

The object of the entire course is to furnish the student with such manual skill, and such a general knowledge of the tools and methods of working in the arts in which wood and metal are employed, as will give him an intelligent comprehension of any mechanical operation or device, and enable him, with proper study and practice, to master any handicraft or mechanical profession to which his attention may be directed in after life.

The instruction in the mechanical arts is given either in the regular college course or in a special mechanical course of three years. In the first case the student takes the workshop instruction and practice after college hours, and in addition to his college studies. In the second, which is designed for those who are unable to take the full college course, his time is about equally divided between academic studies on the one hand, and drawing and workshop practice on the other. The superior training in mathematics and literature obtained in the college course, makes the first plan decidedly preferable for all

who can pursue it, and it has been found by experieuce that the student, unless he is burdened with other work outside the college, is not in general overtasked by taking the workshop instruction in addition to his college studies, since it imposes on him no work to be done at home, and actually serves as recreation and exercise.

The workshops are three in number. The first, for wood-working, has an area of 1,300 square feet, and contains fifteen double benches, with closets and tools for a class of thirty. The second, for forge and vise work, has an area of 820 square feet, and contains six Buffalo forges, twenty anvils, and two long benches with fifteen vises, and an assortment of forge and vise tools, and affords accommodation for a class of from fifteen to thirty students. The third, for lathe work, has an area of 720 square feet, and contains six grindstones, twenty-six lathes for wood and metal-working, four engine-lathes and a circular saw. The shops are illuminated by electric lamps, and the lathes and grindstones, as well as the dynamos which supply the light, and the ventilating fans, are driven by a steam-engine of twenty-five horse power.

In the three years' course, the subject of commercial products embraces the study of raw and manufactured products. The former belongs to the Department of Natural History, and divides itself into four parts, viz:

1. The consideration of raw materials from the mineral kingdom; as metals, ores, coal, petroleum, etc.

2. Of those from the vegetable kingdom; as grain, timber, textile fabrics, tea, coffee, etc.

3. Of those from the animal kingdom; as silk, wool, fur, hides, meat. etc.

4. The consideration of the sources of supply and lines of conveyance, or what is generally known as "Commercial Geography."

The *first* division of the subject is taught practically, by the examination of the things themselves.

The *second* division, or "Economic Botany," begins with the study of the relations of the vegetable and mineral kingdoms, and of the nutrition and reproduction of plants. This is followed by the study of their parts, their uses and products.

The *third* division, or "Economic Zoology," is taught in the same manner as the first and second.

A half term of thirty two lessons is assigned to each part.

A report of a special committee of the New York City Board of Education, submitted in 1887, states that "the number of students availing themselves of these opportunities for manual training is 185; their ages range from fourteen to twenty-one years, the average age at admission being fifteen years and three months."

Of all the "regular course" pupils, who have selected work-shop training in addition to their prescribed studies, but one was found to become backward in those studies; of the other pupils making such selection, it is reported that the manual training has benefited them in the conduct of their ordinary studies.

The annual cost of imparting instruction is reported as nearly $3,600.00, of which about $100.00 represents the cost of materials.

The total cost of shop plant, as stated in a report of October 31, 1888, has been $8,640.06.

6. The Hebrew Technical Institute.

The Hebrew Technical Institute was organized in 1884, having as its object the preparation of Jewish youth for industrial callings.

It is a manual training school. The requirements for admission are: That pupils shall be twelve years of age and have reached the fourth grade in the New York public schools. These requirements have not in the past been rigidly enforced, as many boys of thirteen or over had not yet reached the fourth grade.

The school hours are from 9 till 4 daily. Special instructions in wood-carving are given from 4 to 6 P. M. on Mondays and Thursdays.

The course of instruction is as follows:

First—Arithmetic, from fractions to the completion of arithmetic.

Practical geometry; completing the ground in Hill's geometry.

Physics and mechanics; history and geography; language lessons; composition and penmanship.

Materials used in the arts and industries.

Instruction in physics is illustrated by experiments, and the pupils have made models illustrating the application of the mechanical powers. Instruction in this department takes two hours daily.

Free-hand drawing, commencing with free-hand measurement, then drawing of geometrical solids, sketching and drawing from cast with charcoal, one hour daily.

Mechanical drawing.

1. Use of tools.
2. Developments of simple solids which are cut out in the shop from these drawings.
3. Simple designs, which are cut out in thin wood with the hand-bracket saw.
4. Elements of working drawings.
5. Drawings of the principal joints, which are constructed in the shop.
6. Fifty problems in practical geometry.
7. Projection drawings.
8. Machine drawing to scale.
9. Elements of architectural drawing.
10. Tracing and blue printing.
11. Drawing trustees and patterns made in the shop.

Course in the shop.

1. Work in pasteboard.
2. Bracket sawing.
3. Construction from white holly of some simple article for use.
4. A course of twenty lessons, bringing into use the principal tools, glue and nails.
5. A course of construction work, in which the previous course is applied.
6. A course of lengthening timbers, and its application to buildings.
7. Patternmaking; series of twenty-one patterns, from which molds and casts are made by pupils.
8. Castings made by the pupils, to be finished up by them.
9. All work above mentioned to be made from drawings made by the pupil.

At the close of the first year in the shop, metal work is commenced.

The course of this branch includes vise-work, chipping and filing, turning brass and iron, brass finishing, and the course in forge work.

In the shop pupils are taught the use, care and nature of tools employed.

The various classes are periodically taken to leading manufacturing establishments of New York, to witness the practical application of processes.

A leaflet published by the Industrial Education Association, September 24, 1888, gives the following extract from the report of the director:

"This is the difference between this school and a trade school. A trade school is one where some special branch is taught—a school where segarmaking or plumbing or some special industry is taught. Surely, ill-fed boys of twelve and a half or thirteen, who never saw a hammer or chisel, are not fit to be set at these trades. And how many boys of thirteen want to go to work at a trade? Let them however go to a school, not where a trade is taught, but where they are taught to use tools and to draw and to continue their ordinary education, and when they get to be fifteen or so, and then they are not too old to enter life, what have they learned? They have learned to like tools and to want to be machinists, or electricians, or carpenters, and when they enter their fields they will become skilled mechanics. They have the foundation laid stout and deep; the foundations of intelligence and skill, for they know the principles not of one trade but the principles that underlie many trades. We dare not, in fact it is impossible to, take boys as young as we do, from the sources they come, and teach them first, trades. First, we get them to love work and want work, then find out for what kind of work they are best fitted, and then assist them in that at which they will do best. Intelligence and skill are both needed, one as well as the other. We have here the brain and the hand. We teach here that it is as honorable to be a greasy mechanic as the cleanly book-keeper; that the field of industry offers as broad and broader opportunities than those of commerce, that production is as honorable as distribution.

"This is the ground work of the school. If it continues, as I trust it will, it must prove a credit to the city and to the community. Its influence will widen year by year, and the emancipation of our people will be greatly furthered through its existence. Its success depends on liberal support. It is not a charitable institution for the distribution of moneys, or the care of the sick, but a preventive institution, an educational institution, a social factor. It should be supported liberally so that it can have the best instruction, the best management, the best equipment. It should be conducted in the wisest and broadest manner. Only thus can the best results be attained. It should command the support of every intelligent member of the community as the realization of an idea which will do more to keep our people in the van of the car of progress than any other institution. It should become an institution not for the poor alone, but for all who choose to enter its doors. I look into the future and see (provided the spirit I have lauded prevails) a fine building equipped with a

laboratory, workshops and lecture room for boys and girls. And I see years after young men and women graduating therefrom, and entering into honest competition in those walks of life which for centuries they have avoided. I see through this best commingling in all employments the solution of the race problem. I see the Jew and the Gentile alike working at the forge and the bench. I see Jewish builders, plumbers, masons and machinists. I see the mercantile spirit no longer monopolizing the attention of our youth, and the historian of our race's progress will then accord to all those who interest themselves in the broad and philanthropic cause of this institute due credit as the founders of this social reform.

"The number of pupils now in attendance is 87. At the same date last year, 86. Of the pupils who were members of the school at the last report, 23 are now engaged in industrial work. There are now ten pupils forming our highest class ready to leave its walls and enter practical life. During the summer the usual summer course was held, during which period the attendance reached 125. In considering the number of pupils it should be borne in mind that many of those who enter the school and do not complete the course are very materially benefited by the instruction they here obtain. In any employment these boys enter, the 'handiness' they have acquired endows them with additional usefulness.

"Cases of absence from illness are rare. The excellent condition may be attributed in no small degree to the abundant exercise that the boys get in the manipulation of the tools. The boys here do not sit for any great length of time, but perform much of their work standing, and are taught to employ all their activities. Many of our pupils show more than the average physical growth as a result of their work here. No serious breaches of discipline have taken place that call for mention. The kindest methods of treatment are employed. Appeals in cases of necessity are made to the pupil's sense of honor. He is taught to respect authority and property even when not watched. No undue reference is made to the fact that the pupils are the recipients of the kindness of others, but a constant endeavor is made to develop the thankfulness that best expresses itself in manly and courteous behaviour, diligence at work and a pride in the accomplishing of good results. The severest penalty that can be inflicted is detention from the shop or drawing-room, and it is an exceptionally phlegmatic pupil that will not linger fascinated about the lathe or the engine room long after the stated school time is over.

"The course of instruction has been extended. The equipment of the metal working shop now includes two engine lathes, 2 drill presses, 2 speed lathes, 1 planer and 15 vises, with all the necessary tools used with these machines. The vise work in a series of eight progressive exercises teaches the pupil the properties of cast iron and the use of the hammer, chisel, file, straight-edge, calipers and square, bevel

gauge, dividers. The utmost accuracy is required. Exercises of the lathe are first commenced in type metal, followed by work in steel and brass. The vise work done here is far beyond the average of that which is done by boys of similar age in other institutions. In the wood-working department the main features of the instruction hitherto followed has been continued. The instruction commencing with simple exercises in pasteboard work as an introduction to wood-work, includes joinery, wood turning, patternmaking and cabinet-making. The features of instruction in mechanical and free-hand drawing have not been materially modified. All work in the shop is made from drawings of the object and from measurements taken by the pupils. Instruction in the principles of mechanics is given practically, and the pupils are required to construct models illustrating the principles. This work thus gives practice in the use of tools and instructs most thoroughly in the elements of science. The instruction in the English department averaging for each class but two hours daily, includes history, geography, arithmetic, geometry, physics, language lessons, letter writing and industrial topics. As our pupils are on an average under thirteen when they enter, it is necessary that instruction in these branches be given. Furthermore, as the purpose of the school is to develop intelligent young men they must be grounded in those principles which underlie the arts and industries.

"Summarizing the course of instruction it will be seen to fall under three heads: Shop-work in wood and iron, drawing, free hand and mechanical, the English branches and physics. Each pupil attends during the six hours which form the school day, and receives instruction in all the departments. The longer he stays in the school the following facts become apparent: First, whether he has any mechanical aptitude; second, whether he likes wood or iron work, and this evidences itself by the work he does for special work. Thus one boy will make a dynamo or an engine while another will pro-

ERRATUM, *p.* 231.

Read, 7. The Industrial Education Association.

7. The Industrial Education Commission.

The outline and purpose of the work of the association are best stated by the following extracts from publications issued by it at different times.

"The growth of the association work is a most excellent example of the development of an idea. In April, 1880, there was incorporated in New York city, the kitchen-garden association. The objects of this association were the promotion of the domestic industrial arts among the laboring classes, by giving to the children of the same, and

to such others as might be deemed desirable, gratuitous instruction in household arts, according to the principle of the kitchen-garden system; and also to promote a wide and correct diffusion of the principles upon which the system had been founded, and to prevent its degenerating into careless and erratic methods of teaching, which might expose the system to misconception in its objects and operation.

"It cannot be claimed that the kitchen-garden system was educational, save indirectly. It was practical philanthrophy. The term seems to have originated with Miss Emily Huntington, who published a book on the subject in 1878. By 'kitchen-garden' Miss Huntington denoted an application of some details of Froebel's kinder-garten system to domestic service. The association was convinced of the value of the application, and in its first annual report, made in May, 1881, was able to state that during the year the principles of the kitchen-garden had been applied in 29 classes, comprising 999 children in New York city and vicinity alone. Many other cities followed New York's example, and similar classes were reported as existing in Brooklyn, Philadelphia, Boston, Albany, Troy, St. Louis, Cincinnati, Wilkes-Barre, Meadeville, Newark, Poughkeepsie, Elmira and Newport. In this initial report the same note is sounded that is heard again in the last report which has just been issued. It is that too much stress cannot be laid upon the importance of training teachers for this work. Persons must not be permitted to take it up without adequate preparation. In thus insisting on a professional training for teachers, the association, in the earliest days of its history, placed itself upon a proper plane, and made its future successful development possible. One year later, in May, 1882, one or two points of advance were chronicled. The kitchen-garden classes have been continued in all the cities in which they had previously been introduced, and new classes had been established in Orange, Rochester, Yonkers, St. Albans, Cedar Rapids, Germantown, Chestnut Hill and Cleveland. A normal class had been started, and was meeting with gratifying success. A graduate of the normal class had attempted an extension of the system so that it would suit boys as well as girls. While this extension had not been developed, yet progress was reported. The third report, issued in 1883, told of a successful but uneventful year. The fourth report, however, marks a significant stage in the association's development. The board of managers had begun to feel that their present work was too limited, that their fundamental principle admitted of a wider application than it was receiving. This feeling found expression in a resolution passed March 21, 1884, which reads as follows: '*Resolved*, that at the next regular meeting of the association the subject of the dissolving of the kitchen-garden association, with a view of re-organizing under a different name and upon a broader basis, be presented, and action taken thereon. It is proposed to make this change because, first, the title

"Kitchen-garden association" is too limited in its scope; second, experience has proved that a more advanced work in addition is essential; third, it is desirable that industrial training for schools in general, for older pupils, and for boys, be added to the present work; fourth, other systems having been developed, it seems advisable to incorporate them with our own.'

"In this dissolution the old was not displaced entirely by the new, but it was relegated to a subordinate position. A standing committee on kitchen-garden was provided for, and to it the direction of that work was confided. The result of the re-organization was 'The Industrial Education Association.' In April, 1885, its first annual report was published; and in its whole tenor indicates that a greatly enlarged work has been undertaken. In this report it is stated that the association was organized, first, to obtain and disseminate information upon industrial education, and to stimulate public opinion in its favor; second, to invite coöperation between existing organizations engaged in any form of industrial training; third, to train women and girls in domestic economy, and to promote the training of both sexes in such industries as shall enable those trained to become self-supporting; fourth, to study and devise methods and systems of industrial training, and secure their introduction into schools; also, when expedient, to form special classes and schools for such instruction; fifth, to provide instructors for schools and classes, and, if necessary, to train teachers for this work.

"The work of the year, as might have been expected, had been largely preparatory. Industrial education had been studied, committees on specific topics organized and set to work. The conclusion had been reached that a center should be established, where, by practical experiment, the value and feasibility of manual training could be demonstrated. To this end the association had applied to the board of education of New York city for the use of a school building one afternoon in the week, for the purpose of holding classes, after the regular school hours, in sewing, domestic economy, designing, modeling, simple carpentry, and the use of tools. The association offered to assume the entire care and expense, and to open the classes to the inspection of teachers, school trustees, and members of the board of education. This request was refused, and on the quite defensible ground that the board was not authorized to permit the use of a school building for any educational work not wholly under its own control. During this year, also, General John Eaton, United States Commissioner of Education, invited the association to prepare an exhibit for the New Orleans exposition; but it was deemed inexpedient to attempt any such exhibition at that time.

"The second annual report, issued in May, 1886, of the industrial education association, is somewhat more elaborate than its predecessors. The work of the association had attracted sufficient attention to

incur misrepresentation, and it was deemed necessary that an adequate explanation of the term 'industrial' be given. The report insists that by this term is not meant the teaching of any trade, nor the introduction of the teaching of trades into public education. But, the report continues, quoting Mr. Washington Gladden, 'we hold that there is an industrial training, which is neither technical nor professional, which is calculated to make better men and better citizens of the pupils, no matter what calling they may afterward follow; which affects directly, and in a most salutary manner, the mind and character of the pupil, and which will be of constant service to him through all his life, whether he be wage-worker or trader, teacher or clergyman. The training of the eye and of the hand are important and essential elements in all good education. These elements the State is bound to furnish.'

"The objects of the association were defined anew, and the more essential of them are, 1°, to secure the introduction of manual training as an important factor in general education, and to promote the training of both sexes in such industries as shall enable those trained to become self-supporting; 2°, to devise methods and systems of industrial training, and to put them in operation in schools and institutions of all grades; 3°, to provide and train teachers for this work.

"Numerous classes had been started in various branches of industrial work, and an accomplished and efficient superintendent appointed to organize and develop the work. The special committee on industries had been busy investigating the practical working of the industrial feature wherever introduced into reformatories and similar institutions, and was able to report that three very important conclusions had been reached. These were, 1°, that every child in these institutions should be trained to become a producing factor in the community; 2°, that, if such training is to have permanent value in the after-life of the child, it must be conducted on a basis of education to the child, and cannot be made to any extent a source of revenue to the institution; 3°, that the moral results of such training are most satisfactory.

"Perhaps the greatest triumph of the year was the success of the children's industrial exhibition, held under the auspices of the association. The exhibition was opened on March 31, and lasted one week. To meet the often expressed wish that this exhibition might show the results attained in cities where industrial education has already gained a definite place in the curriculum of public instruction, special invitations were extended to New Haven, Jamestown, Chicago, Cleveland, St. Louis, Philadelphia, Boston, Worcester and other cities. The work of all grades of pupils, irrespective of age, was solicited with a view to showing the results possible under systematic training. To the cordial responses from these cities, as well as to the efficient coöperation of schools and institutions in and near New York, much of the

success of the exhibition was due. It comprised no fewer than seventy separate exhibits from schools and institutions, representing the work of thousands of children, and one hundred and forty individual exhibits. This exhibition did a great deal to increase the popular appreciation of the importance of industrial training. The attendance of visitors was very large, numbering over seven thousand persons. The press treated the exhibition with gratifying cordiality.

Great as is the progress noted in the report of 1886, that of 1887 surpasses it. The work had now reached a still more advanced stage. Nearly a year ago the association had outgrown its quarters, and the large building, No. 9 University Place, formerly occupied by Union theological seminary, was leased for a term of years. The building was altered and refitted; and in December last, two classes in drawing, one in carpentry, one in sewing, one in cookery, together with the kindergarten and domestic training department, were in progress. In April this number had increased to seven classes in drawing, six in carpentry, six in sewing, twelve in cookery, together with the kindergarten and domestic training department. The association has had under instruction 4,383 pupils, 2,991 of whom have been members of classes held outside of the building but instructed by teachers in the employ of the association. Over 400 pupils were enrolled in vacation classes held in July and August. A course of public lectures was given and attracted much attention. A museum has been opened which serves as an object lesson in industrial education. It is always open to visitors, and many teachers and other interested persons visit it daily. From it the eye takes in at a glance the possibilities resulting from the combination of manual and mental exercises, and sees how they supplement and depend upon each other. The museum comprises at present some twelve separate exhibits of drawing, together with specimens of carpentry, joinery, lathe and forge work, representing the Chicago public schools, Worcester high school, Montclair public schools, New Haven public schools, Hebrew technical institute, College of the city of New York, Baltimore manual training school, Chicago manual training school, and the Women's institute of technical design. Still other exhibits are in course of preparation.

A library fund has been secured, and by fall a large reference and circulating library of educational works will be at the disposal of teachers and students. But the most important of the new features is the establishment of a college for the training of teachers. This college will aim eventually to become a professional school for teachers, not a mere normal school in which education and preparation for teaching go hand in hand, but a professional school in the sense that a law school or a medical college is a professional school. As the law school has its moot courts and the medical school its dissecting-room, to combine practice with theory, so this college will have its model school.

In this model school the training which the association advocates will be given,—here the new system, which combines the old and the new, will be taught,—and the association hopes to have in it a strong confirmation of the belief which it strives to propagate.

The college building No. 9, University Place contains a large lecture hall in which free lectures are given. Monographs on educational topics are also issued from time to time.

The statement of principles which the industrial education association issued recently is a most excellent pedagogic creed. It should be carefully perused by every teacher. The substance of it is as follows:

The association holds,—

1. That the complete development of all the faculties can be reached only through a system of education which combines the training found in the usual course of study with the elements of manual training.

2. That the current system trains the memory too largely, the reasoning powers less, the eye and the hand too little.

3. That industrial training, to have its fullest value, must be an integral part of general education. While valuable in some measure alone, it is alone little better than manual training as leading to the learning of trades.

4. That it is not the aim of the association to teach trades. That boys and girls will, if educated according to the system which it advocates, be better able to take up the study of any particular trade, it recognizes as one of the results of the system. It is the development of all the faculties which it holds to be the essential aim of the system.

5. That the fact is generally recognized among those best informed on the subject of education that the kindergarten system produces the best results with young children. The association claims that the system which combines industrial training with the usual and necessary branches is nothing more than a development of the kindergarten theory—a system found wise for young children modified and adapted to children of more mature growth.

6. That it holds the belief, that as children, wherever found, possess the same faculties and develop the same characteristics, this system should be introduced into all classes and grades of schools, the private as well as the public schools, and not alone in the primary public schools, but in all those of more advanced grades.

7. It holds that this system tends to the development of certain moral qualities as well as to the development of the intellectual faculties.

8. That the various occupations which are by this system given to the children, render study less irksome than any system can in which the exercise of the faculty of memory is alone involved.

9. That there exists in this country a wide-spread disinclination for

manual labor which the present system seems powerless to overcome. There is a wide range of occupations which our boys and girls might with advantage enter were it not that they are prevented from doing so by a false view of the dignity of labor. That one of the results of this system of education will be to destroy a prejudice which in a measure arises from a want of familiarity with hand-work.

"10. That the first and last object of the association, the main reason for its existence is the creation of a public interest in this system and a public belief in its value.

"To carry out the objects of the association, the methods to be employed in this work are substantially as follows:

"I. By distributing writings and documents explanatory of the theories of industrial education and also of the practical methods of engrafting industrial training upon the present school system as an integral part of a common school education. These documents are to be sent to all educational centers with a view to stimulate inquiry and interest.

"II. By sending persons competent to lecture upon the same matters; to add personal influence to the documentary explanations and to invite the interest of persons influential in educational matters.

"III. By sending trained teachers to point out practical methods of engrafting manual training upon existing schools and institutions of learning, or if need be to establish independent schools for industrial training.

"IV. By sending teachers to work in schools wherever needed throughout the country.

"To accomplish these objects there is to be established a center of information at No. 9 University Place, which shall contain:

"I. A library comprising all literature relating to the subject of industrial training and kindred topics.

"II. A permanent exhibition or museum of articles illustrative of methods and results of this work.

"III. Courses of lectures bearing upon the same subjects.

"IV. Normal classes for the training of teachers and lecturers for the work above outlined.

"Incidental to this normal instruction there will be children's classes for the instruction of pupils in the various branches of manual education.

"Further incidental to these normal classes, the association is prepared to furnish lodgings and board to young women who come to this city from a distance for the purpose of attending such normal classes.

"Incidental to this boarding and lodging there is domestic training work, both as a means of reducing expenses in conducting the lodging department, and as a means of instruction to those who are to engage in that branch of handiwork."

The prospectus of the proposed college for the training of teachers, opened in September, 1887, made the following announcement:

"The college for the training of teachers is to be founded to give systematic instruction to persons desirous of entering on the profession of teaching. For the present at least, the instruction given will be almost wholly confined to those hitherto neglected factors in education which may be included under the name of industrial training. Both male and female students will be admitted to the college.

"Efficient and practical instruction in the best methods of industrial education will be given by a competent corps of instructors, under whose direction and criticism students will also teach the pupils of the model school.

"As a general rule no student will be admitted to the college until he shall have obtained the age of eighteen years. In special cases this requirement may be suspended by vote of the faculty.

"Applicants for admission are required to pass an approved examination in the following subjects:

"Plane geometry—as much as is contained in the first five books of Davies' Legendre.

"History of the United States.

"Special students are received and permitted to select such courses as they may choose and be found qualified to enter upon.

"The regular course of study is as follows:

"*For Male Students.*—History and science of education, 2 hours a week; mechanical drawing and wood-working, 4 hours a week; modeling and industrial art, 3 hours a week.

"*For Female Students.*—History and science of education, 2 hours a week; mechanical drawing and wood-working, 3 hours a week; modeling and industrial art, 3 hours a week; domestic science, 5 hours a week.

"Students are also required to teach, under supervision, in the model school, and to attend various courses of lectures on educational, scientific and literary subjects that are arranged for. Certain courses of instruction and lectures in other colleges in New York city will also be open to the students."

TUITION FEES.

The terms for tuition for the full year's course are $60. The terms for special and partial courses will be made known on application. A limited number of scholarships have been established to aid deserving students.

In connection with the college for the training of teachers, a model school for boys and girls was opened in 1887.

This school includes a kindergarten, a primary grade and a grammar grade; in which, besides the usual branches taught in the public schools, special attention is given to industrial drawing, clay model-

ling and the use of tools. The course for girls embraces a graded system of sewing and cutting, together with a course in cookery.

Tuition $4.00 a year.

8. New York Public Schools.

A special committee of the Board of Education on "Course of study and school books" submitted a report to the board in June, 1887, containing, in general outline, a course of instruction in manual training. This course included modeling in clay, construction work in paper, pasteboard and other suitable materials, and drawing to scale for both boys and girls; carpenter work or the use of wood-working tools for boys, and sewing and cooking for girls. Suggestions were made as to the way in which the necessary time might be found, and an analysis of the probable expense to be incurred was furnished, together with various other considerations relevant to the subject. The report concluded with a resolution commending to the board these views of the committee and recommending their adoption.

This report was adopted by unanimous vote of the board, and then by further resolution the committee and the city superintendent were directed to prepare in detail a course of study in harmony with the views presented, and also, by means of a teachers' manual, suggestive and expository, to furnish a full statement of the particulars and methods required by the new work. The board directed that after the course and manual should be prepared, "manual training should be tested in a limited number of grammar schools, not to exceed six male departments and six female departments, together with those primary schools and departments only that promote to the same, and that a reasonable time be allowed for the experiment, and that these exercises should not be introduced into any school except upon application by the trustees of the ward in which said school is situated."

The work of preparing the new course and manual was a task full of difficulty and responsibility. Not only must the new element be given in all of its details and the methods to be pursued be explicitly stated, but the old course of study must be so modified as to find time for the new element without adding to the labors of either pupils or teachers.

"This difficult work was satisfactorily performed. The course as now prescribed is a decided improvement upon its predecessor. No study has been omitted, but comparatively unimportant details have been left out, and methods of treatment have been judiciously modified.

"In every instance the alteration made in the course of study has been for the better, and deserves to stand, entirely irrespective of the question of the retention or the rejection of manual training."

The time assigned to the manual training exercises is one hour and

a half per week for the primary schools and three lower grammar school grades, and two hours per week in the five upper grades.

From six and one-third to about nine per cent. only of the working time is required for the new element. When it is considered that the drawing and a large part of the object lessons are now included in the manual training, it will be seen that the time actually taken from the other studies forms but a small part of the whole.

The estimate of expenses made by the committee was as follows:

A. Estimate of expense of introducing manual training, as recommended, into all the schools, and maintainance, the first year:

Workshop outfit, $300.00 per department, 60 departments,	$18,000 00
Kitchen outfit, $200.00 per department, 60 departments,	12,000 00
Workshop supplies, $50.00 per department, 60 departments,	3,000 00
Kitchen supplies, $100.00 per department, 60 departments,	6,000 00
Sewing supplies, $50 00 per department, 60 departments,	3,000 00
Construction supplies, $25.00 per department, 240 departments,	6,000 00
Teachers' salaries,	65,000 00
Assistant superintendent's salary	3,500 00
Constructing or preparing 120 rooms at $100.00,	12,000 00
	$128,500 00

B. Estimated expense of maintenance of manual training in all the schools in the next succeeding years:

Workshop, 10 per cent. of outfit,	$1,800 00
Kitchen outfit, 10 per cent. of outfit,	1,200 00
Workshop supplies,	3,000 00
Sewing supplies,	3,000 00
Construction supplies,	6,000 00
Teachers' salaries,	65,000 00
Assistant superintendent's salary,	3,500 00
	$89,500 00

C. Estimated expense of introducing manual training, except workshop and cooking, as recommended, into all the schools, and of those two subjects into one-third of the grammar schools and the maintenance for the first year:

Workshop outfit, $300.00 per department, 20 departments,	$6,000 00
Kitchen cutfit, $200.00 per department, 20 departments,	4,000 00
Workshop supplies, $50.00 per department, 20 departments,	1,000 00
Kitchen supplies, $100.00 per department, 20 departments,	2,000 00
Sewing supplies, $50.00 per department, 60 departments,	3,000 00
Construction supplies, $25.00 per department, 240 departments,	6,000 00
Teachers' salaries,	25,000 00
Assistant superintendent's salary,	3,500 00
Constructing or preparing 40 rooms at $100.00,	4,000 00
	$54,500 00

D. Estimated expense, in the next succeeding years, of maintaining manual training, except workshop and cooking, in all the schools,

together with workshop and cooking in one-third of the grammar schools:

Workshop, 10 per cent. of outfit,	$600 00
Kitchen, 10 per cent. of outfit,	400 00
Workshop supplies,	1,000 00
Kitchen supplies,	2,000 00
Sewing supplies,	3,000 00
Construction supplies,	6,000 00
Teachers' salaries,	25,000 00
Assistant superintendent's salary,	3,500 00
	$41,500 00

A report of the board of education, under date of September 19, 1888, states that this course of study, prepared by the committee, has gone into operation in twenty departments, having on register 9,847 pupils. The report continues as follows:

"The special teachers employed and their annual salaries, are as follows:

Workshop, four at $800,	$3,200 00
Cooking, one at $1,200,	1,200 00
Cooking, one at $600,	600 00
Sewing, two at $800,	1,600 00
Sewing, two at $600,	1,200 00
	$7,800 00

The equipment of the four workshops now in operation has cost: $502.38; 498.75; 830.75; 855.00. That of the five kitchens: $521.53; $631.03; 746.82; 777.71; 715,00.

These figures are far in excess of the estimates in the committee's report of June 29, 1887, and must be substituted for them in considering the extension of this scheme of instruction, though if the demand for such outfits should become continuous, it is likely that competition would reduce the cost considerably. The estimate for constructing or preparing rooms was unnecessary, rooms having been found ready to hand, or provided in connection with alterations in progress through the committee on buildings or the trustees.

Manual training supplies are, as far as practicable, furnished through the depository on pass-book orders of the trustees, in the same manner as those in charge of the committee on supplies. Articles that cannot be kept in stock are procured on trustees' "applications," except those for immediate consumption in the kitchens, which are bought by the teacher in charge, who is reimbursed monthly.

The expenditure to date for supplies is as follows:

Depository supplies,	$2,893 64
Workshop supplies,	112 71
Kitchen supplies,	68 73

The total expenditures to date have been:

For salaries,	$1,491 39
For equipment,	6,078 97
For supplies,	3,075 08
For printing,	300 80
	$10,946 24

By the end of the year the sum appropriated for this purpose ($15,000) will apparently be exhausted.

Your committee, in considering the details of the new course and manual, came to realize more strongly than before, the benefits and advantages to the pupils promised by the incorporation into the curriculum not only of the special handicraft exercises, but of provisions for the employment of the hand and eye, wherever possible, in the studies already prescribed, and we remain now of the opinion that manual training, in the broad educational sense which the committee have endeavored to embody in the course, should be continued where it now exists, and should be extended as rapidly as circumstances will permit, with a view to its final adoption for all the schools.

An experiment hardly begun cannot be expected to furnish corroboration of this opinion. Yet some advantages are already apparent, such as increased interest in school work, better, because voluntary, order and the development of mental activity in certain cases, which are worthy of notice. The employment of the smallest possible number of individuals as teachers, most of them serving in several schools and in different wards, tends to uniformity in methods, facilitates supervision and has made it possible to adjust fairly the salaries paid. Your committee has had great difficulty in finding teachers possessing both the technical knowledge and the general education requisite to carry out the special subject in the spirit desired. This circumstance alone would prevent a rapid increase in the number of schools adopting the course. The want of room, too, in most of the schools, operates in the same direction. New schools, as erected, and old ones when remodeled, will for some time furnish almost the only available room. Your committee has reason to believe that further applications will be made for the manual training course when in these or other ways the necessary accommodations can be found, and there should therefore be made provisions for a moderate increase in the number of manual training schools.

To maintain the manual training course during the year 1889 in the schools where it is now in operation there will be required, approximately, $10,000, and it is recommended that this amount be increased in the annual estimate to $25,000 so as to provide for an increase in the number of such schools.

The following extract from a communication to the board of educa-

tion, from the principal of one of the grammar schools, is given in full as a typical experience:

"The first term of the course of instruction in this department, under the provisions of the new 'Teachers' Manual,' closed on June 30, having been begun on February 1. My teachers and myself have, therefore, had five months' experience in the practical application of what is commonly called 'Manual Training.'

"I am very much pleased to be able to state that while I felt, before entering upon the 'experiment' perfectly sanguine of success, the favorable results obtained have far exceeded my expectations.

"The subject of Mechanical Drawing, including geometrical problems, required to be taught in all the grades was begun under, I at first believed, serious disadvantage. The lesson that we learned from the work of the children is well worth, I believe, describing with some detail.

"It was necessary to thorough and effective work, on beginning this subject, an absolutely new work in all the grades, that every class should start on the subject matter assigned for the lowest or eighth grammar grade, and pass to the next higher along the line of the work of the several grades as laid down in the manual, only after preceding grade work had been intelligently completed. Further, to quote from the manual, 'The applications of geometrical problems and the graphic solutions of the theorems require very accurate representation, hence the drawing is to be done by mechanical means.'

"For more than three months the only drawing instruments obtainable were the ordinary foot-ruler and lead-pencil. Foreseeing this unavoidable delay in obtaining the necessary supply of proper instruments, I determined to supply the place of compasses by using strings and pins. This was done by myself and teachers, however, with a great deal of trepidation as to the kind of work we would obtain. We certainly anticipated that great effort would be needed to obtain from the most attentive pupils even passable results, and that all we could hope for would be the intelligent understanding by the pupils of the ideas to be conveyed, leaving accuracy of drawing out of the question.

"From day to day we were amazed at the ardor of all the pupils, and at the beauty and accuracy of the geometrical drawings, accomplished by even the youngest boys with pins for centers of circles and with strings for radii. You, sir, saw some of the work and can vouch for a portion of this statement.

"If I had needed argument or experience to make me an advocate of what is called manual training the results obtained in this way from the very youngest pupils, the keen delight taken by them in the doing of their work, their excessive, painstaking care shown and demanded under such disadvantage—which care and engrossed attention could have sprung only from their feeling of delight in their work—the

absolute freedom on the part of the teacher during these exercises from the necessity of 'keeping order,' all these would have opened my eyes to the value of this change of methods in teaching; for that is really what this 'innovation' really is. It is not, as some misunderstand, so much an introduction of new subjects to displace subjects previously taught as a change of method in all subjects wherein the child can be permitted to use his activity of hand and eye in the doing of work conveying educational ideas to his brain.

"If teachers who have not examined the subject closely could realize how valuable to us has been this change from a disciplinary standpoint alone; if they could see, as we do, that a large percentage of the expenditure of energy by the teacher now required in 'keeping order' could be saved, and that their classes would become as eager to receive instruction and do the work required as the teacher is to impart it, the demand for the 'new methods' would come from every section of the city.

"As one result of my five months' experience, and a result worthy, I believe, of being emphasized, I find, after a consultation with my teachers, that I can abolish the practice of 'keeping in' after three o'clock for disciplinary purposes.

"Much of the supposed necessity for punishment of this kind arises from the use of methods which do not interest the child and against which the child's nature rebels. Why not then help ourselves by the use of methods to which the child takes naturally and readily, and thus avoid almost endless friction and loss of energy on the part of both teacher and pupil?

"The work I speak of above and the spirit evinced by the pupils were not confined to selected cases; they were general; in fact, boys with the previous reputation of being 'troublesome,' 'uneasy,' 'restless' and 'inattentive' showed in most instances the very best results.

"In the 'workshop,' the logical continuation of the mechanical drawing-work, covering the higher five of the eight grammar grades, there has not occurred a single instance of misbehavior needing even rebuke.

"Further, working on the mechanical drawing with strings and pins for drawing instruments, as I have described, not only has the work in all other directions been fully and satisfactorily done, *but each class has accomplished, in this subject, the full work of all the preceding grammar grades;* so that now, on beginning the new term, *each class will properly enter upon the work allotted to its particular grade.* That is to say, for instance, the fourth grade class will take up the work in mechanical drawing belonging to the fourth grade of that subject, having thoroughly covered the preceding grades during the last term; and so, in like manner, all the other classes in the department. And this, not because the pupils were at all 'rushed' or 'driven' by their teachers, but because the boys did the work with perfect ease and *could not be held back.*

"And here is as good a place as any to say something of the teachers.

"When the first proof sheets of the new manual reached us, some time before its publication in book form, I cut them in slips so as to divide the grades and subjects; and I distributed the slips among the teachers to be copied, as far as possible simultaneously, and thus avoid any loss of time. This had to be done so as to accommodate the teachers of the male and female departments, as we had but one proof-copy for both. This done, we met for consultation after school-hours, as, indeed, became our almost weekly practice during the term. At our first meeting the following remark was made in reference to the 'mechanical drawing.'

"'Why, this demands from the eighth grade alone work in geometry upon which girls have failed in normal college examinations! We'll never do it!' Of course, the reference was to such problems as: 'Construct a triangle similar to a given triangle;' 'divide a straight line into any given number of equal parts;' 'construct a parallelogram when an angle and the adjacent sides are given,' etc., etc.—all found in the lowest grade.

"After the *method of presentation of this work* had been made clear, and the evident ease and delight of all the pupils in doing the work became manifest, of course this preliminary 'scare' subsided.

"The work in 'free-hand drawing,' *especially in the lower grade*, has shown fully as surprising results. The readiness with which, after a few weeks, the boys of the eighth, seventh and sixth grades rapidly sketched objects set before them, each boy representing the object correctly as seen from his own position, was almost a revelation. The 'kitchen' of the female department has furnished us with a great variety of familiar objects which we have freely used. The fact that in the younger boys of these grades we have found a much greater facility than in the older boys of higher grades, would seem to indicate great mistakes in our previous methods of teaching this subject.

"In the 'workshop,' too, this same feature was very striking; the work done by the younger boys was, as a rule, the better. When, in time, we shall receive from the primary departments promotions whose training shall have been founded upon the study of 'form' and 'drawing' under the same system of modeling in clay and drawing directly from the object, what additional agreeable surprises will manifest themselves none of us can as yet, anticipate.

"Contrary to general expectation, I have found very few instances of accident occurring from the handling of sharp tools in the 'workshop;' and these few were trival and noticeably confined to the older boys."

Reports from four other schools bore substantially the same testimony. "Similar communications were not obtained from the principals of primary departments, for want of time."

XVII. OHIO.

1. The Technical School of Cincinnati.

At a meeting held by the Order of Cincinnatus, July 8, 1886, a committee was appointed to investigate the subject and the feasibility of organizing a technical school.

The committee making a favorable report, an association was formed and incorporated under the laws of the State of Ohio, July 27, 1886, under the name of "The Technical School of Cincinnati."

The association completed its organization October 25, 1886, by electing a board of fifteen directors, and the school was formally opened for the admission of pupils November 1, 1886, in the art rooms of Music Hall.

The Commercial Club of Cincinnati took formal action, as a body, on the subject of the technical school in November, 1887—although a number of its members had been interested in the movement since its beginning—and have since borne nearly half the expense of the school.

As stated in the articles of incorporation, the object of this school shall be to furnish pupils instruction and practice in the use of tools, mechanical and free-hand drawing, mathematics, English language and the natural and physical sciences; to develop skill in handicraft and to impart such a knowledge of essential mechanical principles as will facilitate their progress in the accquirement of manual trades.

"The mistake of thinking the technical school a refuge for refractory or indolent pupils should not be made. If a boy cannot be made to study, and must be coerced if he ever learns anything at all, he is out of place in the technical school.

"The course in this school requires of its students as much application and continuous honest effort as does the course in any academic institution of equal rank. The advantage claimed for its hand training is that it requires *thinking.* The work is never so long continued that it becomes mechanical or automatic, but is changed so frequently and is varied in its nature so that it requires as much mental effort—although of a different kind—as is required in the study of mathematics or of languages.

"To guide the hand in its ever-varying tasks requires the continuous directive effort of the mind and results in after-reflection on the degree of success or failure in the work attempted, of disappointment and of plans for overcoming the opposing obstacles, and the tangible results are to show when success at last crowns the efforts of the

genuine student. The result of the thinking, the planning, the final overcoming of the difficulties and the production of the finished project is education in its truest sense, the awakening of dormant faculties, the development of the latent capabilities.

"But some object to schools founded on this system, because hand training is the plan followed in educating the defective classes. That there are those who cannot comprehend reasoning in the abstract without first having been taught by means of tangible objects should be no reason for objections to our methods. If such wonderful results are accomplished by such means with those who are lacking in mental capacity, why not expect grander and fuller results from those in the complete possession of all their mental attributes? If such great things are attained in the education of the blind, deaf mutes and those who are deficient in their mental powers, through the agency of that wonderful piece of mechanism which distinguishes the highest of created beings from all others—the human hand—why not look for the fullest exemplification of the value of this training with those in the full possession of all their powers, both mental and physical, in schools of hand culture."

ADMISSION.

Candidates for admission to the first year class must be fourteen years of age, and should in general be prepared for entrance to the high school.

Pupils are admitted without examination on certificates from principals of intermediate or grammar schools, showing them to be of good moral character and to have the necessary qualifications.

Candidates for admission to the first year class must pass a satisfactory examination in reading, spelling, writing, common school geography, English composition, with correct use of capitals and punctuation, arithmetic, including fundamental rules, common and decimal fractions, denominate numbers, percentage, interest and general problems.

Candidates for admission to the advanced classes may present themselves at the same time, and are examined in the work (book studies) accomplished by the class to which admission is desired.

Those who have completed the mental work of the various classes may be admitted as special students in the drawing and shop work, being excused from other recitations at the discretion of the superintendent. "In general, the most satisfactory results are attained only by the close association of the mental and manual work."

The school year is divided into two terms of twenty weeks each. The tuition is as follows:

First-year class, per year, ...	$75 00
Second-year class, per year, ...	100 00

Third-year class, per year, ... $125 00
Fourth-year class, per year, ... 150 00

Pupils must furnish their own books, drawing instruments and materials, scales, rules, calipers, etc., and their own aprons and overalls.

The school furnishes all shop tools and materials.

Drawing instruments and materials cost from $10 to $15 for the first year and from $5 to $6 thereafter. The cost of books is about $5 or $6 per year.

Every pupil is required to make a deposit of $5 to cover possible damage to the property of the school, which must be increased whenever the assessments exceed the original deposit. This is returned less assessments, if any, when the pupil severs his connection with the school.

The course of instruction and practice is as follows:

FIRST YEAR.

Mathematics.—Review Arithmetic (business forms and usages), Algebra.

Science.—Physical Geography, Introductory Science, Botany of Plants.

Language.—English Composition or Language Lessons, United States History.

Drawing.—Lettering, Outline and Shading in Charcoal from Objects, Free-hand and Mechanical, Designs for Wood Carving.

Shop Work.—Carpentry and Joining, Finishing, Wood Carving.

SECOND YEAR.

Mathematics.—Algebra, Plane Geometry.

Science.—Botany of Woods, Book-keeping, Physics.

Language.—Rhetoric, English History.

Drawing.—Isometric Projection, Mechanical Perspective, Projection of Shadows, Ornamental Lettering, Pattern Draughting, Free-hand Work, Pen Sketching.

Shop Work.—Wood Turning, Carving on Turned Surfaces, Patternmaking, Sheet Metal Work.

THIRD YEAR.

Mathematics.—Geometry, Plane and Solid, Trigonometry.

Science.—Chemistry and its Applications in the Arts.

Language.—English Literature and Composition, Civil Government (German or French).

Drawing.—Orthographic Projection, Brush Shading in India Ink, Model Drawing, Architectural Drawing, Decorative Design.

Shop Work.—Molding and Casting, Forging, Welding, Toolmaking, Brazing, etc.

FOURTH YEAR.

Mathematics.—Mechanics, Trigonometry and Surveying.

Science.—Physiology, Geology, Theory and Science of Steam Engineering.

Language.—English Literature and Composition, Elements of Political Economy (German or French).

Drawing.—Water Color, Landscape Architecture, Topographical Drawing, Architectural Design, Machine Construction.

Shop Work.—Machine Shop Practice, Chipping, Filing, Lathe Work, Screw Cutting, Drilling, Planing, etc.

The work of the school day commences at 9 A. M. and closes at 3.30 P. M., with thirty minutes from 1 o'clock for lunch.

To avoid monotony the classes change work and recitation rooms, when possible, every hour. Under no circumstances is work of any kind allowed for more than two hours continuously.

"In all cases the aims of the teachers are to direct the efforts of the pupil, to cause them to investigate for themselves, to become students. Whenever practicable the pupils are required to do experimental work, and to write out the results of their observations.

"Particular stress is laid on the study of the English language and literature. In this connection, in addition to the outlined work, periodical visits are made to various manufacturing establishments and and other places of interest. Generally those places are selected in which the work is similar to, or closely connected with the topics of study at that time. The pupils are required to make observations and to take notes, which they must embody in an essay or descriptive account of their visit.

"Writing and spelling also come under this head. All papers must be neatly written and are marked on construction, punctuation, capitalization and spelling. Special lessons in spelling are given three times each week; in defining, in spelling and in constructing sentences, in which the selected words shall be properly placed.

"Pupils who desire to enter the scientific courses of colleges, universities of polytechnic schools after completing the course in this school, are allowed to take, with the approval of the superintendent, German or French in place of English literature and composition, in the third and fourth years of this course.

"Graduates of this school are admitted without examination and free of conditions, on the certificate of the superintendent, to the scientific courses of the following institutions:

"Columbia University, Washington, D. C.

"Purdue University, Lafayette, Ind.

"St. John's College, Annapolis, Md.

"Swarthmore College, Swarthmore, Pa.

"Rose Polytechnic Institute, Terre Haute, Ind.

"Case School of Applied Science, Cleveland, O.

"Certificates are granted only to those whose work has been thoroughly satisfactory in every particular throughout the entire course."

The following is the plan of the course in drawing, 1888–9, arranged topically:

FIRST YEAR.

(1) Free-hand work on blackboard, working drawings for shop; (2) lettering, mechanical and free-hand; (3) outline and shading from objects in charcoal; (4) free-hand shading in pencil from machines, etc.; (5) mechanical drawing, use of mathematical instruments, pen-lining, etc.; (6) free-hand sketches of machines or tools, with dimensions accurately marked, from which mechanical drawings may be made, mechanical drawings of same with details and sections; (7) free-hand decorative drawing and designs for wood-carving.

SECOND YEAR.

(1) Isometric projection; (2) mechanical perspective from models, problems in plain and oblique perspective; (3) free-hand perspective, blackboard and paper; (4) projection, formation of objects, tinted; (5) projection of shades and shadows

with ruling-pen; (6) ornamental lettering; (7) geometric construction; (8) pattern draughting; (9) sketches, with pencil and with pen and ink.

THIRD YEAR.

(1) Orthographic projection; (2) brush shading in India ink; (3) drawing from casts and models in light and shade; (4) geometrical ornamentation and principles of decorative design; (5) architectural drawing, including plans, elevations, sections, details, perspective and working plans; (6) household decorative designs, as applied to wall papers, carpets, etc.

FOURTH YEAR.

Architectural Course.

(1) Topographical drawing; (2) study in water colors; (3) landscape architecture, arrangement of lawns, drives, parks, etc.; (4) interior decoration, staircase halls, libraries, etc.; (5) original design of a house with plans, elevations, sections, details, etc.

Mechanical Course.

(1) Topographical drawing; (2) engineering, draughting, grades, fills, sewers, etc.; (3) square and V-threaded bolts, etc., shaded in India ink; (4) machine construction, bevel gears, spurs, mitres, eccentrics, etc.; (5) final project drawing of machine, shaded in India ink, with details and working drawings.

This course of drawing is based on the theory that a knowledge of the art of drawing is fundamental to accurate mental conceptions. Its object is to train the powers of observation before proficiency with pen or pencil is expected. To teach the eye to see all there is of an object, and seeing, to delineate it. As the imaginative mind is able to comprehend ideas sooner than the unimaginative by the greater facility with which it forms mental representation to them, so the student trained in the use of drawing pencil outranks the one who is untrained, not only in the drawing and mechanical work, but in the sciences, mathematics and language.

The work of the drawing course cannot be accomplished entirely in the school time. In some cases the theories and principles are given and the pupil does the work at home, it is then brought in for inspection. The greater part of the work, however, is done at school under the immediate supervision of the instructor.

SHOP EQUIPMENT.

Two shops are equipped at present, the carpentry department and wood-turning department. Both departments are at present in the same room which is 60x90 feet.

There are twelve double wood-workers' benches in each equipment, which are furnished with iron coachmakers' vises of the latest improved pattern. Each bench has two complete sets of tools consisting of rip, hand and back saws, hammer, mallet, oilstone, oil can, try, bevel and carpenter's squares, dividers, scratch awl, screw-driver, jack, smoothing and jointer planes. Besides these there are kept in the tool room a number of special and general tools, to which all of the pupils have access as occasion may require. Each pupil has an individual set of chisels, gouges and carving tools, which are kept in locked drawers. For the condition and safety of these tools the pupil is held responsible.

In the turning department there are seventeen speed lathes and one engine lathe, a circular saw for getting out stock, emery grinder and grindstone. As in the carpentry department each pupil has an individual set of turning chisels and gouges. The machinery is driven by a seven-horse power engine.

SHOP INSTRUCTION.

"In shop practice the work done is intended to be disciplinary and to promote habits of self-reliance. The faculty of making plans and the ability to execute them are the objective points rather than manual dexterity or unusual skill in any particular line of work.

"In beginning the instruction in any department the simplest tools or appliances are usually taken first. In the carpentry department the saw is the first tool used. The instructor gives a lecture or explanatory talk on the theory of the tool and the uses to which it may be put, illustrating the same by doing practical work, asking and answering questions until the subject is clear to every member of the class; each one then proceeds to do the work for himself, the instructor giving assistance and individual aid to such as may need it. As soon as the pupils are fairly proficient in the use of one tool another is given out, until they can saw fairly straight with or without a guiding line, plane a true surface, use the marking gauge, plane accurately to a gauge mark, 'square a piece,' etc.

"They are now ready to lay out work from drawings and from their instruction in the drawing room are able to make drawings of simple rectangular objects in plain projection. Each pupil is required to use a blank book in which the working drawings for the shop are made *by himself* to a specified scale. These drawings are made from the object to scale or from a blackboard sketch on which the correct dimensions are given in figures. The course in shop practice and drawing is arranged in progressive lessons and thus the pupils are soon able to make intricate drawings in orthographic or isometric projection, *freehand*, from which they may make accurate models in the shop.

"The shop instruction after the first practice work consists of examples of the various kinds of joints, mortises and tenons, splices, scarfs, frames, etc. *Pupils are given no practical work to do before they know how to handle the tools.* It is always discouraging to the novice to attempt work beyond his ability and to fail in it.

"In this work besides the physical powers the powers of concentrated attention and thought are brought out and developed. One great value of such training is in the aid it gives in determining the life work of those who come within its influences. It aims to aid the pupil in finding the work for which he is best fitted at the least possible expenditure of time and money, to develop the tastes when discovered, that he may know in making a choice that it is a wise one.

"The school instruction is widely different from that in vogue in shops and factories in the training of apprentices, in that the object sought is the mastery of tools and the training of the judgment, rather than immediate apparent results. The average foreman or employer seeks to make the labor of the apprentice remunerative as soon as possible. Generally when he can do a thing well he is kept at that particular thing, that his work may become more valuable as his skill increases.

His knowledge of other lines of the trade is usually 'picked up' by chance or he obtains it by being placed in unusually fortunate circumstances. The qualifications of such a one when he becomes a tradesman are usually limited to proficiency in a few things instead of a wide and available knowledge of many.

"It must not be inferred that general scholarship is neglected in this school. Indeed, though the hours devoted to purely mental work are fewer than in other schools, the general scholarship of a certain number of students taken at random will be almost sure to outrank the scholarship of an equal number of high school or academy pupils, and will be certain to do so in the natural sciences, drawing and mathematics."

RESULTS.

Some of the results of the work are shown by the following extracts:

The practical work of the school began with a class of *three* pupils, and closed the year, June 22, 1887, with eighteen.

The second year opened September 5, 1887, with an enrolment of forty pupils, which has since increased to sixty-four.

"Pupils are not always correctly judged. The one who in the grammar school or academy was thought to be a sluggard, a dunce or an incorrigible, when placed in a technical school often develops exceptional ability and outstrips with ease, both in mental and manual work, those who were thought to be his superiors, because of the awakening of the faculties which were waiting for the magic touch of congenial occupation to bring them into abundant life.

"The apparent dullards and idlers are not always those who derive the greatest benefits from manual training. The bright pupil who has a natural taste for mechanical pursuits and who does well anywhere because of his tractability and teachableness, at once shows an interest and enthusiasm in the work that is contagious among his fellows. However, it is not claimed that brilliant results will be obtained in each and every case. It is a melancholy fact that there are some children who will not be taught in any school, and who oppose all attempts to instruct them, and what knowledge they do acquire is mainly by coercion or by the happy selection of instructors.

"It is interesting to the inquiring observer to note the acquirement of skill, the development of tastes for certain lines of work, the discovery of natural abilities hitherto unsuspected, the finding out of the kind of work best liked, or of what is equally valuable, of that which is *not* liked.

"Generally, it is not long after a number of boys are started in work of this kind, before some of them will be asking for permission to do work for themselves or friends outside of the regular class time. Then they will undertake small jobs for other persons, and presently some will be purchasing tools to be used in their leisure moments. It is a well-established fact that the general health of students in manual

training schools is better than that of the students in other schools of like grade which have no manual training or equivalent exercise.

"In this connection it is remarkable that because of ill health some of our best pupils were never able to do the work of an entire school year before coming here, but since their connection with this school have scarcely missed a day in attendance. This they attribute to the beneficial effects of the physical exercise received in the workshop. They notice this more particularly because, not being accustomed to manual labor, the shop work at first seemed to weary them excessively, which feeling passed away as soon as they became accustomed to the work. They now look forward to the shop time as being the best part of the day.

"By their training in the use of tools, students are enabled to manufacture simple apparatus for experimenting in the physical laboratory, and not only the simple, but some of the more complex. The inventive faculties are stimulated, and in working out one idea materials are collected for others. Thus habits of observation and reflection are acquired, without which no one ever becomes a successful student, or a scholar in the full sense of the term.

"The shop work is but the practical application of the instruction received in the drawing room, for no work is allowed to be done in the shop without first making an illustrative or a working drawing. And a drawing, instead of being a confused mass of lines to the student, soon becomes a living representation, full of meaning.

"The extraordinary advantages of these schools to those possessing mechanical tastes or inventive talents need but to be presented to be recognized. The technical instruction is not narrowed to the details of a few trades, but the use of tools and practically the foundation principles of all trades are taught. This is also the case in drawing, in which it is not intended that the ornamental and artistic shall be wholly crowded out by the technical.

"The science course in the technical school is arranged to harmonize as closely as possible with the technical work, as well as with the course in mathematics, so that while the *how* is being taught in one department, it is closely followed by the *why* in another. At the same time due provision is made for the study of language and literature. The inventive genius who starts out with such an equipment is surely a long way on the road to success.

"On the other hand, the reasons why those who do not possess mechanical ability, in a marked degree, should take a course in a technical school, is, perhaps, expressed in the arguments we often hear put forth by educators in classical and mathematical schools: 'If you have a dislike for languages or for mathematics, that is the very reason why you should study them. It shows a deficiency in the mental nature in that particular direction, and should be made up by special effort to overcome it.' But this may be asserted with better

reason in regard to technical schools, for failure in this line of study more often results from carelessness and inattention, than from lack of mental capacity. A case of a pupil passing through a course of this kind without showing proficiency in some line of technical work is exceedingly rare, indeed.

"Apart from its educational value the benefits which may be derived from the physical training received, will amply repay one for the time spent in this department, in this respect being almost equal to gymnasium work. It is a fact established beyond all cavil, that those students in schools and colleges who take a regular and judicious amount of gymnasium work, stand at the head of their classes in scholarship, in physical and mental health, in endurance and capacity for work, and are longer lived than those who do not.

"In speaking of technical education, quite a number of business men of Cincinnati have said to the writer: 'I wish I could spare the time to take the entire course of drawing and tool instruction in your school, not that I would expect to make a direct use of the knowledge, but for the satisfaction of knowing how to do things for myself. Whenever I desired to have any mechanical work done, I could make a drawing of what I wanted and would know when the work was properly completed. Many times in my experience would knowledge of that kind have been particularly valuable to me.' The frequent recurrence of such remarks has been surprising."

2. Case School of Applied Science.

Leonard Case, the founder of the Case School of Applied Science, on the 24th of February, 1876, executed a trust deed, setting apart certain lands to endow and establish a scientific school in the city of Cleveland. In the trust deed he directed the trustees—

"To cause to be formed and regularly incorporated under the laws of Ohio, an institution of learning to be called the 'Case School of Applied Science,' and located in said city of Cleveland, in which shall be taught, by competent professors and teachers, mathematics, physics, engineering—mechanical and civil—chemistry, economic geology, mining and metallurgy. natural history, drawing and modern languages."

After the death of Mr. Case, January 6, 1880, the necessary steps were taken to secure legal incorporation.

In 1881 instruction was undertaken, on a limited scale, in the residence of the late Mr. Case, on Rockwell street, and continued there until June 1885. In September, 1885, the school was transferred to a new building on Euclid avenue. This building was burned in October, 1886, but was immediately rebuilt.

ADMISSION.

Candidates for admission to the first class of the regular courses of

study must be at least sixteen years of age, and must be prepared to pass an examination in English grammar and composition, arithmetic, including the metric system of weights and measures, algebra, geometry, plane and solid, and the elements of physics and chemistry.

Candidates for any other class than the first are also examined in studies previously pursued by the class they desire to enter.

Persons who desire to pursue special branches, and who are not candidates for a degree, are permitted to enter the school as special students, without passing the regular examination. They must be prepared to pursue profitably the work which they select and must conform to the regulations of the school with regard to recitations and term examinations. If desired, a certificate of proficiency in the subject pursued is given to those who have studied in any department at least one year.

Arrangements are made in the laboratories for those who desire to fit themselves in special branches, either for teaching or for practical work.

The regular courses of study are completed in four years, of two terms each. The school year begins about the last of September and ends the middle of June.

FEES.

The fee for tuition is seventy-five dollars a year, and the fee for chemicals and use of instruments and apparatus is twenty-five dollars a year. Each student is required, upon entrance, to deposit twenty dollars as security against possible injury to the building or furniture, and for breakage of apparatus in the laboratories. This deposit is retained until the student severs his connection with the school, and it is increased whenever the damage to school property or laboratory breakage exceeds the amount of the first deposit. When the student leaves the school the balance of the deposit is returned to him.

COURSES.

The school provides courses of instruction in civil engineering, mechanical engineering, electrical engineering, mining engineering, drawing, physics, chemistry, mineralogy, geology, mathematics, astronomy and the English, French and German languages. These courses of study are intended to give a thorough training in the principles of physical science, and to offer a practical education as a preparation for scientific pursuits.

The following regular courses of study have been established; each course requires four years for completion, and for proficiency in any of them the degree of Bachelor of Science in the course pursued is conferred:

I. General Course.
II. Civil Engineering.

III. Mechanical Engineering.
IV. Mining Engineering.
V. Electrical Engineering.
VI. Physics.
VII. Chemistry.

The general course is intended for students who do not desire to give as much time to a single topic as is given in the other regular courses. During the last two years the course is largely elective. The choice of any study is subject to the approval of the president and of the professor in whose department the student desires to work.

THE COURSE IN MECHANICAL ENGINEERING, in detail, is as follows:

FIRST YEAR.

FIRST TERM.	SECOND TERM.
Algebra and Trigonometry.	Analytical Geometry.
Chemistry (Lectures).	Chemistry (Lectures).
Chemical Laboratory.	Chemical Laboratory.
Rhetoric.	English Literature.
French.	French.
Mechanical Drawing.	Descriptive Geometry and Drawing.

SECOND YEAR.

FIRST TERM.	SECOND TERM.
Mechanism.	Mechanism.
Machine Drawing.	Machine Drawing.
Shop Work.	Shop Work.
Surveying.	Calculus.
Calculus.	Physics (Lectures and Recitations).
Physics (Lectures and Recitations).	German.
German.	French.
French.	

THIRD YEAR.

FIRST TERM.	SECOND TERM.
Steam Engineering.	Steam Engineering.
Machine Drawing.	Machine Design.
Shop Work.	Shop Work.
Calculus.	Mechanics.
Mechanics.	Physics (Lectures and Laboratory).
Physics (Lectures and Laboratory).	German.
German.	Slide Valve, Link Motion, Governors.
	Mechanical Engineering Laboratory.

FOURTH YEAR.

FIRST TERM.	SECOND TERM.
Mechanical Engineering.	Mechanical Engineering.
Machine Design.	Machine Design.
Shop Work.	Thesis Work.
Mechanical Engineering Laboratory.	Shop Work.
	Mechanical Engineering Laboratory.

METHODS OF INSTRUCTION.

The methods of instruction include lectures, recitations, laboratory

practice, and field work. While a thorough theoretical knowledge of each subject is required, great importance is attached to practical training, as a source of mental discipline, as well as a preparation for active pursuits. Practical work is, therefore, made an important feature in the course of study, and each student is expected to spend a large portion of his time in the laboratories and drawing rooms, or in the field. All students receive instruction during the first year in rhetoric, including English composition, and in English literature. In rhetoric, special attention is paid to diction, construction of sentences, figures of rhetoric, and properties of style. In English literature, the lives of noted authors are studied, together with selections from their most popular writings. In French, during the first year, three hours a week are devoted to pronunciation, reading, and the construction of the language.

The study of German extends throughout the second and third years. The first year is devoted to acquiring the principles of the language; the second year to translations from scientific German. At the end of the third year, the student is expected to have acquired a sufficient knowledge of the languages to be able to use French and German scientific works. It is attempted to give every student a thorough working knowledge of algebra, trigonometry, and analytical geometry, and an elementary knowledge of differential and integral calculus. Students who pursue courses in physics, astronomy, or engineering, in addition, take a more complete course in the calculus, and study differential equations and analytical mechanics. Those selecting mathematics are directed and assisted in a more extended course of reading.

Five hours a week are devoted to mathematics during the first three years by all students except those of chemistry, who are only required to complete the elementary course in calculus.

DRAWING.

Instruction in mechanical drawing is begun at the beginning of the first year, with a series of introductory lectures on the use of drawing instruments and materials.

Descriptive geometry is begun about the middle of December, and continued to the close of the second year. This course includes orthographic projection, spherical projections, shades, shadows, and perspective.

The graphical work in shades and shadows is also accompanied by exercises in tinting and shading with water colors.

In perspective, after the student has become familiar with the principles, he is required to execute a finished perspective drawing of some architectural or engineering design.

In the third year, instruction is given in stereotomy and in topo-

graphical mapping. The class take the field under the charge of the instructor, and make a complete topographical survey, which embodies all the methods of work given to the class.

The map of the survey is plotted from the notes and sketches taken, in accordance with the most approved methods in use on the topographical works of the United States Corps of Engineers, supplemented by additional lectures and exercises on topographical conven tionalizing in ink and colors, and in lettering.

The civil engineering students continue drawing in connection with all their techinal studies.

MECHANICAL ENGINEERING.

The instruction in this department is intended to give a thorough theoretical knowledge of such work as the student will be likely to have in practice after leaving the school. In addition to this, the work is made as practical as possible.

The instruction is given by means of lectures, recitations, drawing and design, laboratory and shopwork. The laboratory work is intended to be a prominent feature of the course, giving the student an opportunity for testing the tensile, compressive and transverse strength of materials; the economical use of steam in steam engines and boilers, etc.

Frequent visits are made to the most important manufacturing establishments in the vicinity, enabling the student to become familiar with the processes of manufacture and the arrangement of machinery and shafting, as well as with the mechanism of the machinery itself. The students are required to take full notes and make sketches during these excursions.

Almost all varieties of engineering structures and of manufacturing processes (in many cases the most extensive of their kind in this country) can be seen in the city, and are available for examination and study by the students:

The work is briefly as follows:

Second year—Elements of mechanism.

Third year—Thermodynamics, steam boilers, steam engine.

Fourth year—Hydromechanics, applied mechanics, tall chimney construction, mill engineering.

Drawing and Design.—In the second year the students make complete working drawings from sketches and dimensions that they themselves have taken directly from machinery.

Tracings are made of all drawings, and copied by the "blue process." During the third and fourth years the students will design several machines, including a lathe, boiler, steam engine, etc.

Laboratory Work.—The laboratory work in this department is intended to give to the students practice in such experimental work as they are liable to undertake after leaving the school, and to instil into their minds correct methods of research and original investigation. The work to be done consists of tests of the strength of materials, evaporative power and efficiency of boilers, steam engine tests, showing their economy in the use of steam under various loads, cut-offs, speeds, etc.; calorimeter and condenser tests, etc.

Shop Work.—Enough shop work is required of the students to enable them to become familiar with the more common tools used in modern work. The shops are supplied with all tools and machinery needed to accommodate the students. The second year work consists of patternmaking, in which the students not only become familiar with the tools and appliances used in the work, but are expected to understand how all ordinary patterns should be made so as to be most easily molded. The third year consists of blacksmithing, chipping and filing, and the fourth year of work in the machine shop, with lathe, shaper, drill, etc.

3. Cleveland Manual Training School.

In February, 1885, a small carpenter shop was started in a barn situated on Kennard street, near Euclid avenue, for the benefit of some boys, then pupils in the Central High School. Through the diligence and enthusiasm of those boys the little school and the value of manual training was brought to the notice of some of the business men of the city. One or two meetings were held, at which the question of the establishment of a manual training school in Cleveland was thoroughly discussed. It was decided to form a stock company with a capital of $25,000, with which money to erect and equip a building, and then to charge a tuition fee just sufficient to cover the running expenses.

The Cleveland Manual Training School Company was incorporated June 2, 1885, for the purpose (as stated in its articles of incorporation) of "the promotion of education, and especially the establishment and maintenance of a school of manual training, where pupils shall be taught the use of tools and materials, and instruction shall be given in mechanics, physics, chemistry and mechanical drawing."

"The training of the mind is as much an essential of this school as it is in the high, grammar or primary schools. In this the ability of the mind to conceive, plan and carry out a measure is shown through dexterity in execution. The solution of problems in mechanical drawing; the reduction of a piece of lumber from its rough into a perfect model; the hammering of a crude piece of iron into a definite shape and size; the adjustment of the several parts of a piece of mechanism, more or less complicated; the study of a complete machine of any kind with reference to the discovery of the general design, the adaptability and specific uses of its various parts, its points of weaknesses, etc., all this requires the exercise of the mental faculties just as clearly, persistently and profitably as is required in the study of language, mathematics or science. It is not proposed that this shall take the place of anything else. It affords a peculiar exercise of the mental faculties which no other study affords or can afford. Neither is it intended that any trade shall be taught, as is clearly shown in the course of study pursued."

The members of the company met on September 7, 1885, and elected a board of directors. The school was opened for pupils early in February, 1886. Soon after this, on petition of the board of education, the State Legislature passed an act authorizing the levying of a

tax of one-fifth of one mill for manual and domestic training purposes. This tax amounts to about $16,000. The incorporated company owning the building gave the board of education the free use of this building, machinery, etc. Tuition is free to public school pupils.

Applicants for admission to the school must be at least fourteen years of age, and be of such school grade or have acquirements equivalent to those required for admission to the city high schools.

Pupils are admitted upon certificates of school standing, showing them to be of the required grade, in any school in Cleveland. If no certificate is given, the applicant is given a written examination.

COURSE OF STUDY.

First Year.

Free-hand and Mechanical Drawing, Carpentry and Joining, Patternmaking, Care and Use of Tools.

Second Year.

Geometrical and Mechanical Drawing, Forging, Welding, Tempering, Filing and Chipping.

Third Year.

Machine and Agricultural Drawing, Machine Shop Work, Study of Machines Steam Engines and Boilers.

Pupils attend the school three times each week, each lesson lasting three hours. Two lessons are spent in the shop work and one in drawing. All pass through the same course, which is progressively arranged, so that each department may be considered a preparation for the next. The pupil begins with the simplest tools and work, and passes by degrees to the more complex and difficult. The aim in each department is not to teach the boy to construct any special object, but to make such pieces as will enable him to master, as quickly as possible, the difficult processes.

RESULTS.

The interest which the boys take in the shop school is very great. That more than four-fifths of the pupils asked permission to work in the shops during the vacation at Thanksgiving, and nearly as many at Christmas, is sufficient proof of this statement.

The influence upon the general character of the pupils is well shown by the following extracts from letters:

"By having pleasant and profitable employment a certain number of hours each week, these pupils acquire a new interest in their studies. They are fully sustaining their former rank in scholarship, and more. I believe also that there is a great gain in the matter of discipline. The influence of your school upon the morality of these pupils is certainly very commendable."

"A mutual friend and public educator asked me the other day what the influence of manual training school was upon the high school pupils who attended it. I told him—and the same may en-

courage you—that it was beneficial in many ways. Many of the boys are in my classes and I find them among the best prepared always, and always the most practical. I certainly think discipline is easier from the influence of that school."

The following articles were made by the pupils during the year, 1886, in addition to the regular pieces of the course: Book shelves, screen doors, mariner's compass, center tables, hat rack, pastry screen, milk stool, foot stools, easels, Indian clubs, ball bats, picture frames, cabinet.

"The habit of working from drawings and to nice measurements, has given the students a confidence in themselves altogether new. This is shown in the readiness with which they undertake the execution of small commissions in behalf of the school, and the handiness which they display at home. In fact the increased usefulness of the students still in the school is making itself felt, and in several instances the result has been the offer of business positions too tempting to be rejected. This drawback, if it can be called one, the school must always suffer. The better educated and trained our students become, the stronger will be the temptation offered to them outside, and the more difficult it will be for us to hold them through the course. Parents and guardians should avoid the bad policy of injuring the prospects of a promising young man by grasping a small present pecuniary advantage at the cost of far greater rewards in the future. From the testimony of parents the physical, intellectual, and moral effect of the school is exceedingly satisfactory."

The report of the president of the Cleveland board of education for the year ending August 31, 1887, says:

"There are at present attending, about one hundred and twenty-five boys; and to show the growing interest in the school it may be cited that out of seventy-five boys who began their course in the central high school in the winter term of 1888, forty-eight of them at the same time began to take a course in the manual training school. The purposes of the school are lofty, and as has been said time and again, to teach the American boy the value of labor, its true worth and dignity, to show the mutual need of labor for capital and capital for labor, to teach each to respect the other; this is the chief aim and end of the school. It does not seek to teach trades; it only teaches how to use tools. It does not say that every boy who learns to use those tools shall become a machinist and toiler in the work shop; but if he should find himself adapted to such uses and purposes, it puts him on the high road toward the best attainment thereof."

4. The Toledo Manual Training School.

The Toledo manual training school was established under the provision of an ordinance unanimously adopted by the common council

of the city of Toledo, March 18, 1884, and is maintained under the joint control of the board of education, and the directors of the Toledo University.

Instruction in the work shops and in free-hand and mechanical drawing, is furnished by the university board, while the intellectual studies which must go hand in hand with the development of manual training are furnished in the public school, in the prescribed grammar and high school courses.

The practical effect of the united action of these two boards, is to so enlarge the scope of public instruction in Toledo, as represented by the grammar and high school, as to include instruction in the practical arts, together with free-hand and mechanical drawing. The course, including this instruction, is known as the manual training school course.

The work of the school began October 1, 1884, in rooms in the high school building. The new building was opened December 5, 1885.

The object of the manual training school is to furnish instruction and practice in the use of tools, with such instruction as is deemed necessary in mathematics, drawing, and the English branches of a high school course. The tool instruction includes carpentry, wood turning, patternmaking, iron chipping and filing, forge work, brazing and soldering, the use of machine shop tools, and such other instruction of a similar character as may be deemed advisable to add to the foregoing from time to time, it being the intention to divide the working hours of the student, as nearly as possible, equally between manual and mental exercises.

The manual training school clearly recognizes the preëminent value and necessity of intellectual development and discipline. This school exacts close and thoughtful study with book as well as with tools. It proposes, by lengthening the usual school day a full hour, and by abridging somewhat the number of daily recitations, to find time for drawing and tool-work, and thus to secure a more liberal intellectual and physical development—a more symmetrical education.

"One great object of the school is to foster a higher appreciation of the value and dignity of intelligent labor, and the worth and respectability of laboring men. A boy who sees nothing in manual labor but mere brute force, despises both the labor and the laborer. With the acquisition of skill in himself, comes the ability and willingness to recognize skill in his fellows. When once he appreciates skill in handicraft, he regards the workman with sympathy and respect.

"All the shop-work is disciplinary; special trades will not be taught, nor will articles be manufactured for sale.

"The scope of a single trade is too narrow for educational purposes. Manual education should be as broad and liberal as intellectual. A shop which manufactures for the market, and expects a revenue from

the sale of its products, is necessarily confined to salable work, and a systematic and progressive series of lessons is impossible, except at great cost. If the object of the shop is education, a student should be allowed to discontinue any task or process the moment he has learned to do it well. If the shop were intended to make money, the students would be kept at work on what they could do best, at the expense of breadth and versatility.

"In manual education, the desired end is the acquirement of skill in the use of tools and materials, and not the production of specific articles; hence we abstract all the mechanical processes and manual arts and typical tools of the trades and occupations of men, arrange a systematic course of instruction in the same, and then incorporate it in our system of education. Thus, without teaching any one trade, we teach the essential mechanical principals of all."

"Pupils of the Toledo public schools are entitled to enter the manual training department when they reach the senior grammar, or junior high school grades.

"Pupils of private or parochial schools are entitled to enter if they are qualified for, and pursue a course of study corresponding in grade to that taken by the regular pupils in the senior grammar and high schools grades.

"No pupils are admitted under thirteen years of age.

"Applicants (except those who enter through the grammar and high schools) must pass a good examination in the following studies:

"In spelling, writing and punctuation, penmanship and the use of capitals, in grammar to syntax, and in correct forms of expression in writing; arithmetic to equation of payments, tables of weights and measures and their uses; common school geography; the history of the United States.

"For the residents of Toledo instruction in the manual training school is free as in the other schools; a small charge for material only being made as follows: The first year $6; the second, third and fourth years $9 each.

"For non-residents of Toledo, tuition is payable as follows:

"First year $45. Second year $60. Third year $75. Fourth year $90."

The combined course of instruction covers four years, and the school time of the pupil is about equally divided between mental and manual exercises. One hour per day is given to drawing, and two hours to shop work.

The course of study embraces five parallel lines—three intellectual and two manual, as follows:

First.—A course of pure mathematics, including arithmetic, algebra, geometry, and plane trigonometry.

Second.—A course in science and applied mathematics, including

physical geography, natural philosophy, chemistry, mechanics, mensuration and book-keeping.

Third.—A course in language and literature, including English grammar, spelling, composition, literature, history and the elements of political science and economy.

Fourth.—A course in penmanship, free-hand and mechanical drawing.

Fifth.—(1) A course of tool instruction, including carpentry, wood-turning, forging, soldering and bench and machine work in iron. (2) Instruction in domestic economy, including cookery, garment cutting and making, clay modeling, wood carving, etc.

Students have no option or election as to particular studies; each must conform to the course as laid down and take every branch in its order.

The arrangement of studies and shop work by years is substantially as follows, subject to such changes as experience may dictate:

FIRST YEAR.

Senior Grammar School—(1) *Mathematics.*—Arithmetic.
(2) *Science.*—Physical Geography.
(3) *Language.*—Grammar, Spelling, Writing, English Composition.

Manual Training School—(4) *Drawing.*—Free-hand and Mechanical Lettering.
(5) *Shop Work.*—Carpentry, Joining, Jig Sawing, proper care and use of tools.

SECOND YEAR.

Junior High School—(1) *Mathematics.*—Algebra, Arithmetic.
(2) *Science.*—Physiology and Botany.
(3) *Language.*—Grammar, Rhetoric, Writing.

Manual Training School—(4) *Drawing.*—Free-hand and Mechanical, Designs for Wood-carving.
(5) *Shop Work.*—Wood-turning, Patternmaking, Wood-carving, Clay Modeling.

THIRD YEAR.

Middle High School—(1) *Mathematics.*—Geometry, Arithmetic Reviewed.
(2) *Science.*—Physics.
(3) *Language.*—English Composition, History.

Manual Training School—(4) *Drawing.*—Free-hand and Architectural, Designing from Plant and Leaf Forms.
(5) *Shop Work.*—Forging, Welding, Tempering, Brazing and Soldering, Molding and Casting.

FOURTH YEAR.

Senior High School.—(1) *Mathematics.*—Plane Trigonometry, Mechanics.
(2) *Science.*—Chemistry, Book-keeping, Ethics; Rights and Duties; Laws of Right Conduct.
(3) *Language.*—Political Economy, English Literature and Composition.

Manual Training School—(4) *Drawing.*—Machine and Architectural Details, Decorative Designing.

Manual Training School—(5) *Machine Shop Work.*—Chipping, Filing, Turning, Drilling, Planing, etc., Study of Machinery, Care of Steam Engine and Boilers, Study of Electrical Machinery and Gas Engines.

In the first year German may be taken in place of physical geography; in the second year in the place of rhetoric or physiology; in the third year in the place of history; in the fourth year in the place of English literature.

Instruction in mechanical drawing is somewhat abridged for pupils who may prefer a wider range in free-hand and decorative work.

Instructions will be given each year in the properties of the materials (wood, iron, brass, etc.,) used that year.

Throughout the course forty-five minutes per day are given to drawing and ninety minutes per day to shop work. The remainder of the school day is devoted to study and recitation. Each pupil must recite daily three lessons, which must mainly be learned at home. It is expected that the scholarship of the pupils will be fully equal to the best high school standards. A diploma is given on graduation by the university directors in addition to the regular diploma for high school work.

Latin, French and German are optional studies.

The original purpose was to limit the manual training school course to three years and to make such period conform to the three high school years. Experience has shown, however, that manual instruction is equally valuable to boys of the grammar school grade, and therefore the course has now been arranged to include the senior grammar school year. But the time required of such pupils in the work shops is somewhat abridged.

Ambitious boys, who are sufficiently advanced to enter the high school are admitted to the work of the second year, provided they signify a purpose to complete the course and are willing to devote some extra time to laboratory work to cover the exercises of the first year.

DRAWING.

The course in drawing embraces three general divisions:

1. *Free-hand drawing*, designed to educate the sense of form and proportion; to teach the eye to observe accurately, and to train the hand to rapidly delineate the forms either of existing objects or of ideals in the mind.

2. *Mechanical drawing*, including the use of instruments; geometric construction; the arrangements of projections, elevations, plans and sections; also the various methods of producing shades and shadows with pen or brush.

3. *Technical drawing or draughting*, illustrating conventional colors and signs; systems of architectural or shop drawings; and at the same time familiarizing the pupil with the proportions and details of various classes of machines and structures.

It comprises the following:

First Year.—Principles of projection drawing; free-hand elevation, plans and sections of various objects; the use of drawing tools, including practice in pen-lining, etc.,; working drawings to scale, including plans, elevations, sections and details of various machines and parts of machines; lettering; free-hand perspective in outline from objects.

Second Year.—Geometrical construction; problems in oblique orthographic prosection; water coloring in washes; development of surfaces as applied to sheet metal patternwork; isometric projection; free-hand perspective in light and shade from objects.

Third Year.—Pen line shading; projection of shadows; mechanical perspective; architectural working drawings including plans, elevations, sections perspective and details of building and building construction; free-hand drawing as applied to architectural ornamentation and enrichment.

Fourth Year.—Water color shading; machine design and construction; machine drawing, including the laying out of trains of gearing, etc.; geometrical ornamentation, and the elements of decorative art work; free-hand drawing from casts; pen sketching.

The shop instruction is given similarly to laboratory lectures. The instructor at the bench, machine, or anvil, executes in the presence of the whole class the day's lesson, giving all needed information, and at times using the blackboard. When necessary the pupils make notes and sketches (working drawings), and questions are asked and answered, that all obscurities may be removed. The class then proceeds to the execution of the task, leaving the instructor to give additional help to such as need it. At a specified time the lesson ceases, and the work is brought in, commended on and marked. It is not necessary that the work assigned should be finished; the essential thing is that it should be well begun and carried on with resolute speed and accuracy.

"The time spent in shop-work has never exceeded one and a half hours per day, unless the boys have voluntarily remained after hours for additional practice. Moreover, from these two hours should be substracted fully ten minutes for washing, dressing, etc. A week, therefore, represents less than eight hours of actual work in a shop. Hence, in placing a value upon the time spent, as men count time, it should be remembered that a 'day's work' is all the boys have per week. For carpentry and wood turning they have three hundred hours, or thirty days in all; in forging, molding, brazing and soldering, during the second year, three hundred hours. While this time is ample to furnish an intelligent idea of tools and their uses, of the laws of mechanism, of the properties of wood, iron, steel and brass, and the meaning and force of mechanical words and technical terms, yet it is not so great as to exhaust the boy physically, or to be incompatible with a high degree of proficiency in his purely intellectual studies.

"The zeal and enthusiasm of the students have been developed to a most gratifying extent, extending into all the departments of work. The variety offered by the daily programme has had the moral and intellect-

ual effect expected, and an unusual degree of sober earnestness has been shown. The wholesome moral effect of a course of training which interests and stimulates the ardor of the student is most marked. Parents observe the beneficial influence of *occupation*. The suggestions of the day fill the mind with healthy thoughts and appetites during the leisure hours. Success in drawing or workshop has often had the effect of arousing the ambition in mathematics and history, and *vice versa*. Gradually the students acquire two most valuable habits which are certain to influence their whole lives, namely: precision and method.

"The habit of working from drawings and to nice measurements has given the students a confidence in themselves altogether new. This is shown in the readiness with which they undertake the execution of small commissions in behalf of the school, and the handiness which they display at home.

"From the testimony of parents, the physical, intellectual, and moral effect of the school is exceedingly satisfactory."

Upon the recommendation of the superintendent, graduates of the manual training school will be admitted without examination and free of condition to the School of Mechanics and Engineering of Michigan University, Ann Arbor, Mich.; Sibley College, Cornell University, Ithaca, N. Y.; School of Mechanics and Engineering, Ohio State University, Columbus, Ohio.

EVENING CLASSES.

An evening department is also maintained under the joint control of the board of education and the manual training school directors.

This school has been organized to meet the demand of a large number of young people whose occupations absorb the hours of the day, but who desire to devote a portion of their evenings to further study in elementary and technical subjects.

The course of instruction is graded to conform to the needs of the pupils, and will be advanced from year to year as the classes make progress. Scientific and technical subjects are illustrated by lectures, drawings and appropriate apparatus. Pupils are not required to take the full course, but are allowed to elect such topics as meet their tastes or have a direct bearing upon their occupations.

Thus far instruction in the evening classes has been confined to mathematics, physics and drawing. It is now proposed to give the evening school a wider scope, and to cover the topics of the day schools so far as a demand for such instruction shall be made to appear, upon application of a sufficient number of pupils. No class will be organized until it shall be made to appear to the satisfaction of the Superintendent of Public Schools that not less than twenty pupils will give continuous attendance upon the course of instruction demanded. Upon such application and information classes will be organized and in-

struction given by lectures and otherwise, as indicated by the following schedule:

Term of Six Months.

SUBJECTS OF STUDY.	Evenings.	Hours.
Arithmetic—Elementary,	Thursday.	7½ to 8½
Intermediate,	Friday.	8½ to 9½
Advanced,	Thursday.	8½ to 9½
Algebra,	Friday.	7½ to 8½
American History,	Monday.	7½ to 8½
Book-keeping,	Tuesday.	7½ to 8½
Building Construction,	Tuesday.	8½ to 9½
Botany,	Monday.	8½ to 9½
Drawing—Free-hand, Architectural, Mechanical, Ornamental,	Monday and Tuesday.	7½ to 9½
Debating and Literary Society,	Tuesday.	8½ to 10
English Grammar,	Friday.	8½ to 9½
Experimental Physics—Light, Heat, Sound, Electricity and Magnetism,	Thursday.	8½ to 9½
Ethics—Rights and Duties. The Laws of Right Conduct.		
Geography,	Thursday.	8½ to 9½
Geology,	Thursday.	7½ to 8½
Geometry,	Friday.	7½ to 9½
German—Beginners, Elementary, Advanced,	Tuesday.	8½ to 9½
Machine Construction,	Monday.	8½ to 9½
Mechanics, Applied.—The Scientific Principles relating to Mechanical Operations, Mechanism and Machinery,	Monday.	7½ to 8½
Mechanics, Theoretical.—Statics, Dynamic, Hydrostatics and Pneumatics,	Thursday.	8½ to 9½
Physiology,	Thursday.	7½ to 9½
Physical Geography,	Friday.	8½ to 9½
Political Economy,	Friday.	7½ to 8½
Science of Government—Civics, Constitutional History, etc.,	Friday.	8½ to 9½
Writing and Reading.		

The instruction in drawing is of especial value to carpenters, joiners, wood workers, masons, bricklayers, painters, plasterers, and includes the study of original designs as applied to manufacture of furniture, ornamental iron work, wall and ceiling decorations, etc.

Brief lectures are given from time to time upon important topics, viz:

Construction, practical geometrical problems; how to use the T-square, set square and drawing instruments, bisecting of lines; how to draw and indicate center lines, radical lines and dimension lines, etc., line shading, brush shading, scale drawing, detail drawing; how to construct scales, how to proportion and draw hexagon and square nuts, projection of plain objects, construction of block letters, plain and oblique projection; how to indicate the section of different materials, free-hand sketching, styles of architecture, the orders, details, perspective, sketching, scale drawing, sheet metal, pattern work, projection shading, perspective and perspective shading.

"These lectures, accompanied by drawing and illustrations upon the blackboard, impart instruction that requires years of experience in the workshop to supply."

October 1, 1884, the first class numbered sixty pupils—fifty boys and ten girls.

The second annual report of the school, under date of January 1, 1887, says:

"The attendance upon the manual training school is optional, yet the day classes now number 150; and the evening classes 50; and in addition a number of post graduates of the high school are availing themselves of the instruction furnished in the department of domestic economy.

"The interest in the work of this school continues to increase, and it is belived that each year the classes will increase in numbers. Other communities have been watching the example of Toledo with great interest. The letters of inquiry and personal visits from all sections of the country indicate the widespread interest in the manual training school movement. This is further evidenced by the attention which this topic has received in the leading magazines and newspapers during the past year. Many of our most conservative thinkers regard this practical instruction furnished to all the children of the State and within the reach of all, as one of the most promising factors in the solution of social problems."

XVIII. PENNSYLVANIA.

1. Carlisle Indian School.

The following account of this school was prepared for the Commission by the superintendent, Capt. R. H. Pratt, U. S. Army, whose remarkable success in the training of uncivilized Indian youth is a valuable contribution to sociological as well as educational science. The part played by manual training in the methods of the school is by no means its least important or least interesting feature:

"Industrial education as practiced at this school presents some features not usually found in the trade school, for instance, our pupils have as beginners generally such as an imperfect knowledge of the English language, that instruction by any course of lessons with explanation of process or methods is well nigh out of the question. Of necessity therefore skill in any manual occupation has to be mainly acquired by observation and practice.

"As a consequence of these conditions the education obtained is wholly practical, shoemaking is taught by making shoes, tinning by making tinware, carpentering by working with carpenters at whatever building operations are in progress or such joiners' work as may be necessary, and so on through all the departments operated.

"Not only is this system the only one open to us, but is in the case of undisciplined, uneducated minds the best system to pursue. There is not the mental ability to appreciate a progressive technical course of operations or processes, valuable only as leading to a desired mechanical knowledge and which also depends much for their usefulness or oral instruction given; but the lowest intellect derives satisfaction and encouragement from being able to produce something complete, as a tin cup, a pair of shoes, a horseshoe, or a table, etc.

"The ability once acquired to produce a complete article, all that remains to be done is to strive for excellence by passing on to the more difficult operations in each trade.

"As a consequence of this method the labor of the pupil becomes at once productive, for instance we make all the shoes needed for the school, do all the shoe repairs, make all the clothing for both boys and girls, make for the Government large quantities of tinware, harness and wagons—print two papers; a weekly with a circulation of 6,000, and a monthly of about 3,000, do a large quantity of miscellaneous printing, do almost all the steam fitting and pipe work of the premises, care for the steam boilers, and farm 300 acres of land with the aid only of a head to each department; and in addition place out

during the summer season from 200 to 300 of our students as farmers' helps.

"In all of this work there is good business experience for the student; large quantities of raw material have to be handled, weighed, tested, as to quality and stored—Government contracts have to be filled in a given time, with goods of a uniform grade, which have to be packed, weighed, marked and shipped to the different points required, so that there are many more avenues for instruction in that which an Indian or any youth should know by a system which looks to the manufacture of merchantable articles over one that merely instructs, but does not produce.

"In carrying on this education, simultaneously with a literary, we have found that a half day at school and a half day at labor has given the best results. All departments are organized with two complete sets of pupils, one being at school when the other is at work so a teacher has two schools, a mechanical instructor two sets of apprentices.

"By this method the instructors in all departments have smaller numbers under their care at any one time and are better able to give individual attention.

"Under the system outlined there have been under instruction during the school year 1888–9 —— boys as follows, viz:

At blacksmith and wagon work,	16	At carpentering,	23
At shoemaking,	36	At tinning,	8
At printing,	18	At tailoring,	35
At harnessmaking,	33	At painting,	8
At steam pipe work,	10	At farming,	301
At baking,	4	At care of boilers,	4

"The girls are instructed in all that pertains to household and laundry work, plain sewing, dressmaking, cooking and some tailoring, but nothing has been attempted for the girls aside from these usual and necessary lines.

"In all of the various departments of girls' work excellence is attained by some, and a good degree of proficiency by all. The same system of half a day at work and half a day at study is pursued as with the boys.

"As the students advance a small per diem is paid for the work done. These payments are made in a graduated scale as follows, viz: For the first four months there is no pay, then at the rate of 8 cents per day for the first year, 12 cents for the second year, and 24 cents, the highest attainable, for the third year and after, and in the heavy work of the farm in summer, 24 cents per day. This in the aggregate is not a heavy amount, but small as it is, it wonderfully increases the desire of the student to learn a trade, and enables us to teach the value of money and economy in its uses, and also constitutes an important element of control.

"Experience has demonstrated that literary progress is almost as

great under the half day system with an evening study hour as by having all day at study, while the gain to our class of pupils in other ways is of inestimable value. Then, too, surplus energy and the desire for mischievous pranks are much modified by a half day's hard work, a feature worth considering where there are several hundred young men to be controlled.

"On the health of the pupils, industrial training has great value. Wielding a sledge hammer or sawing an oak plank will stand in reasonably good stead for the sparring or rowing of the college athlete.

"The industrial feature of the school has also another element of value in that it tends to preserve an equilibrium between the abstract and the actual in education. It is practical application of the lessons of the school room now, and at not some future time; it also gives the student an advantage by opening another avenue for excellence which he may pursue simultaneously with his scholastic work; the dull student has a chance to achieve honorable success in a different direction, and at the end of the five years' school course the pupil may be well enough equipped in his chosen trade to enter the labor market and make his own living, providing he is not barred by some of the many oppressive trade organizations."

2. Haverford College.

A machine shop was established in 1884. It is equipped with all the tools necessary for instruction in carpenters' and machinists' work, including hand and machine lathes, planer, shaper, drill press, forge, vises, etc., with a ten horse-power steam engine and boiler.

"The work in the shop is conducted by means of progressive exercises, combining the principles met with in machine construction.

"The students, under the care of the director, are taken to visit machine shops and engineering constructions in Philadelphia and its vicinity."

3. Girard College.

The following statement is condensed from successive annual reports of the board of trustees:

Very soon after the organization of the college the great importance of more instruction for the boys in the use of tools became apparent. In 1848 a committee of the board of directors recommended in the strongest language some mechanical instruction, but from some cause, no satisfactory teaching was then introduced.

The executive committee in April, 1873, recommended that the trades of manufacturing paper boxes and tinware should be taught, but this was not adopted.

It was not until the year 1881, after great deliberation and an elab-

orate report from a special committee, that the board carefully considering *three* plans suggested to them, *First*, establishing machine shops in connection with the school; *Second*, a large establishment with various tools and appliances suitable to many trades, with competent instructors in each branch; *Third*, elementary instructions only: not to teach a trade nor secure a product, but to train the pupil in the use of tools—*instruction not construction*. in fact the Russian system; adopted the last, as not only the most economical, but best adapted to introduction into the college; the first two plans being not only expensive, but in the opinion of some members of the board, not in accordance with the scheme of instruction prescribed by Mr. Girard for the education of his beneficiaries.

Early in the spring of 1882, mechanical instruction was begun. Even then, however, only tentatively and in the single branch of metal working. This trial was so satisfactory that in 1883 an appropriation was made for erecting a commodious and properly constructed building for a greater variety of technical teaching. This school building, placed in the north-west part of the college grounds, is fifty-five feet wide by one hundred and fifty-five feet in length, two stories high, and compares in its details of construction with the best models of workshops of this character. The building was finished in December, 1884, and formally opened with appropriate ceremonies on the 9th of that month. Before the building was completed, elementary instruction in wood work was introduced.

On the 9th of December, 1884, more extensive workshops having been provided, teaching the use of tools on wood-work was introduced, and this has been again supplemented by the erection of a suitable building for a smith shop and foundry, in which branches the pupils are also instructed. Mechanical and geometrical drawing are now taught likewise. It is not our intention to extend this branch of instruction any farther, unless so directed by the light of experience. We believe that all of these are necessary to equip a lad to go out from the college and take his place among the young mechanics of our country. While each study is taught to every pupil old enough to handle tools, careful supervision by the master soon discovers the particular branch in which each seems to display most capacity; to which after he has gone through the whole curriculum, he is permitted to devote most of his attention during the residue of his stay in the college.

Students are taught the use of tools and how to handle them in the work shop as they are taught to read, write and cipher in the school rooms; the one course enabling them to become clerks, book keepers, conveyancers; the other, machinists, furnituremakers, blacksmiths, cabinetmakers, locksmiths, and to obtain employment in kindred trades.

PLAN OF INSTRUCTION.

The plan of instruction proposed to accomplish this end is to commence with the draughting room, where the beginner is required to make a drawing of some simple article or piece of machinery, which he then takes to the wood-working and turning department and works out as a model for the foundry, where he is taught to cast it in metal. From the foundry he takes his casting to the metal bench and there completes it for the purpose of its design. This finished he begins again with some more complicated piece of work in the daughting room, going through the same routine again and again until draughtsman, wood-worker, turner, forger and skilled worker in metal he either goes out into the world competent to earn his living, at least in some one of these employments; or if, in the judgement of the superintendent, the lad, still under eighteen years of age, is sufficiently instructed in each branch, and shows a preference for one, and has not yet found a suitable place, he may be permitted to make himself more perfect in that one which he prefers.

Our introduction of this mechanical instruction seems almost providential in view of the scareness of apprenticeships. Up to almost the end of the year 1884 metal work alone was taught, and during that year only about one-third of the boys who left college entered into mechanical pursuits; of those who left during 1885, and since instruction in ordinary wood work and turning has been introduced, two-thirds have obtained work in mechanical occupations.

4. The Philadelphia Manual Training School.

"The Philadelphia Manual Training School" was opened in September, 1885, with about one hundred and twenty-five pupils.

The object of the school as stated in the second annual catalogue "is the education of all the faculties. 'The whole boy is put to school.' He learns to do by doing, and the manual training school thus educates men who shall combine in one person the thinker and the doer.

"It is not to be supposed that pupils enter the school merely for the purpose of becoming mechanics. The school has a far broader aim than to prepare students for particular trades. Manual training is a means of developing to a high degree certain faculties such as observation and judgment; and, given with the other studies named above, it secures a truly liberal, intellectual and physical development —a more symmetrical education. It tends, also, to foster a higher appreciation of the value and dignity of intelligent labor, and its moral influence is immediate and wholesome."

The school affords to students who have finished the ordinary grammar school course an opportunity to continue the literary, scientific and mathematical studies, and also to receive a thorough course in drawing and in the use and application of tools in the industrial arts.

Promotions to the manual training school are made from the twelfth grade of the boys' grammer, consolidated and combined schools; but no boy is promoted who is under thirteen years of age.

ADMISSION.

The examination for promotion includes reading, spelling, grammar and composition, penmanship, arithmetic, geography, United States history and civil government, science lessons, drawing.

A minimum average of 50 per cent. is required in reading, language and arithmetic, and a general average of 65 per cent. in all branches.

The number of pupils admitted from any school is the *pro rata* of the number from that school who pass the required examination to the whole number who can be received into the manual training school. Schools having more pupils who have passed the examination than can be received have their respective surplus number of pupils admitted *pro rata* to the aggregate number of vacancies in the manual training school as the same may occur.

The pupils of each school are admitted in the order of their averages.

The combined course of study covers three years, and the school-time of the pupils is about equally divided between mental and manual exercises. One hour per day is given to drawing, two hours to shop work and three hours to the usual academic studies.

The course of study embraces five parallel lines, as follows:

First. A course in language and literature, including the structure and use of English, composition, literature, history, social science and German.

Second: A course in science and applied mathematics, including geology, physics, chemistry, physiology, economic botany, mechanics, steam and electrical engineering, mensuration, book-keeping and surveying.

Third. A course in pure mathematics, including arithmetic, geometry, algebra and plane trigonometry.

Fourth, A course in free-hand, mechanical and architectural drawing, designing and modeling.

Fifth. A course of tool instruction, including joinery, pattern-making, wood turning, wood-carving, modeling, forging, soldering, brazing, molding and casting, vise work and mechanical construction.

The care taken to avoid narrowness of training is well shown by the method of teaching history.

" *History* is taught in its principles and applications. Special attention is given to the development of free governments, the progress of civilization, the westward course of empire, industries and inventions, the origin of American laws and customs, the recognition of human rights, the empire of religion and morality, and the relations of man and men.

" In *American History*, the nation is the chief theme. By text book

and by standard authorities, by library and by newspaper, by lectures and by political and industrial maps, the pupil studies the nation. The object of the instruction is to acquaint the pupil with the nature of the institutions, laws and customs of his native land, and to inculcate sound views of his duty as a citizen.

"*General History.* Text book—Barnes—(*Second year*).

" Special study of the history of Greece, Rome, England, France and Germany. Readings in the class from authorities. Construction of historical maps in crayon or in water color.

American History (*Third year*).—Text book—Johnston's American Politics.

Construction by the student of industrial and economic maps, showing movements of populations; the rise of political parties; the growth of canals and railroads; the acquisition of the public domain; the progress of the country in business, commerce, agriculture, education; the changes in State and in Federal Government during the nineteenth century.

The course of instruction also includes the study of *Civil Government* in America; the origin of our State and of our National Government; the functions of the State; the executive, the judiciary, the legislative; municipal government, with special reference to Philadelphia; the citizen; immigration; land laws; duties of public officers; citizenship, its duties and responsibilities."

A special feature of the school is the class visitation to the various industrial establishments, for the purpose of making a personal examination of the various processes of manufacture. Similar visits are also made to the park and other localities for the purpose of geological investigation. The work in the department in English is supplemented by compositions on various industrial topics, which likewise necessitate a visit to industrial establishments, for the purpose of gaining specific information on the subject chosen. The pupils are generally allowed to select their own subjects according to their taste and inclination. Among the topics selected have been the telephone, cotton-weaving, modern shipbuilding, manufacture of flint glass, ordnance, coal fields of Pennsylvania, papermaking, photography, pottery, the lumber interests, silk, mining, scales, locomotives, etc., etc.

Within three years the school has increased from 125 to 325. In June, 1888, some twenty-five or thirty applicants, properly qualified, were debarred from admission for want of room.

Of the first class which was graduated in June, 1888, some fifteen are pursuing their studies in university and college, and the remainder have had little difficulty in obtaining positions, principally those in which skill of hand and administrative ability are the essential requisites.

Among the interesting practical applications of the knowledge obtained in the school may be mentioned the fact that the apparatus

needed in the physical department is made by the boys themselves. The electric lights, also, in the workshop, and the clever device by which the clock at certain hours will tap the bell for change of work, have also been arranged and put in by the boys themselves. Accuracy of judgment as well as deftness of hand are thus developed.

The general effect of this kind of training upon pupils is well stated in the following extracts from a report of the principal:

"As the pupils advance in their work, and realize more clearly its significance, the tendency to remain at school becomes more and more marked, notwithstanding the flattering inducements to good positions made by employers desirous of securing boys skilled in the use of tools. One evidence of this desire to finish the full course is seen in the fact that but one pupil has withdrawn from the senior class since the first of September.

"The beneficial influence of manual work is shown in the discipline of the school. The restless activities of the boys, instead of finding expression in breaches of conduct, find a healthy outlet in every blow of the hammer or push of the plane. As a consequence, the discipline of the school takes care of itself without resorting to the suspension of the pupil, or to his degredation by giving him 'demerit' marks.

"A high moral tone pervades the school, and throughout all its departments a spirit of hearty coöperation on the part of the pupils makes the labor of instruction pleasant and effective. The ability to execute with the hand what the mind plans, fosters a spirit of self-reliance and manliness, and goes far toward the development of character.

"Manual training relieves school life of much of the weariness and frequent stupor incidental to purely mental effort, the alternation of hand with mind work making them mutually restful, beneficial and harmonious, thus reacting favorably on the purely literary work, instead of antagonizing it; it equips the pupil with a clearer and truer insight into the meaning of life; fosters habits of industry, accuracy and physical activity; dignifies and elevates labor; develops the creative faculty, and begets a feeling of confidence and independence based upon the conscious possession of useful practical knowledge."

After a public exhibition of work done in the school a leading newspaper bore the following testimony:

"Not less admirable than the work with tools—possibly more so—was the evidence of improved methods of work in the regular branches which this association of hand skill with head work has developed in this school. The very great use that was made of drawing, for example, was a most admirable feature. Charts and tables for the systematic record of all sorts of knowledge, political, economic, physiological, geographical, astronomical, and what not, these were all tabulated and presented by graphic methods by means

of charts prepared by the pupils. Nothing could be better than this, nothing shown here illustrates better the value as a factor in general education of this training of the doing power."

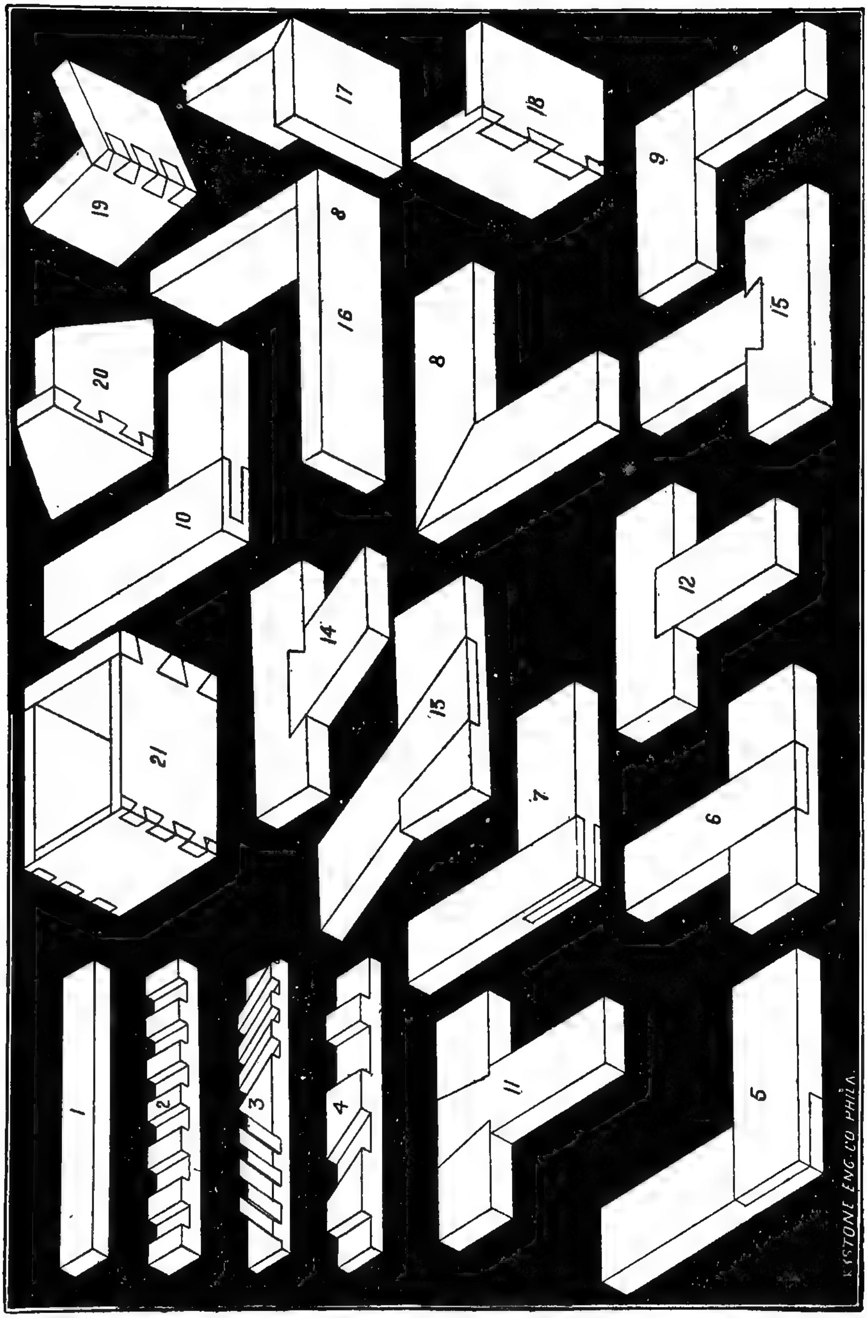
The strong footing which this institution has secured in the short time since its establisement is shown in the following extract from the annual report of the president of the board, published in February, 1889:

"The introduction of machinery into all branches of manufacture has changed the whole industrial world. The apprenticeship system of the past generation has become obsolete, and nothing beyond temporary expedient has yet taken its place. Industrial training in connection with our public school system appears to afford the only practical way of solving the problem thus presented. The board of education in 1885, by great effort, succeeded in getting a small appropriation for a manual training school by way of experiment, and in September of that year the manual training school was opened. This school is not intended to fill the place of the high school. Neither is it a school to teach particular trades. In June, 1888, the first class graduated from this school. The report of the principal of the school to which particular attention is invited, shows that its graduates are in demand in various industrial occupations. The manual training school is no longer an experiment, but an assured success. It has now 310 pupils, and the building is crowded to its full capacity. A number of properly qualified applicants were unable to obtain admission last June for the want of room to accommodate them. Judging from the experience of these three years, and the substantial evidence of the good accomplished by this school, we have no doubt that in June next, 200 or more properly qualified applicants will be turned away for lack of accommodation.

"We need now in the north-eastern section of our city another manual training school of the capacity of the present school, and conducted upon the same plan. Such a school would be filled as soon as it could be provided, and I am fully persuaded that district manual training schools to the number of five or six will be necessary within a few years to meet the requirements of our people."

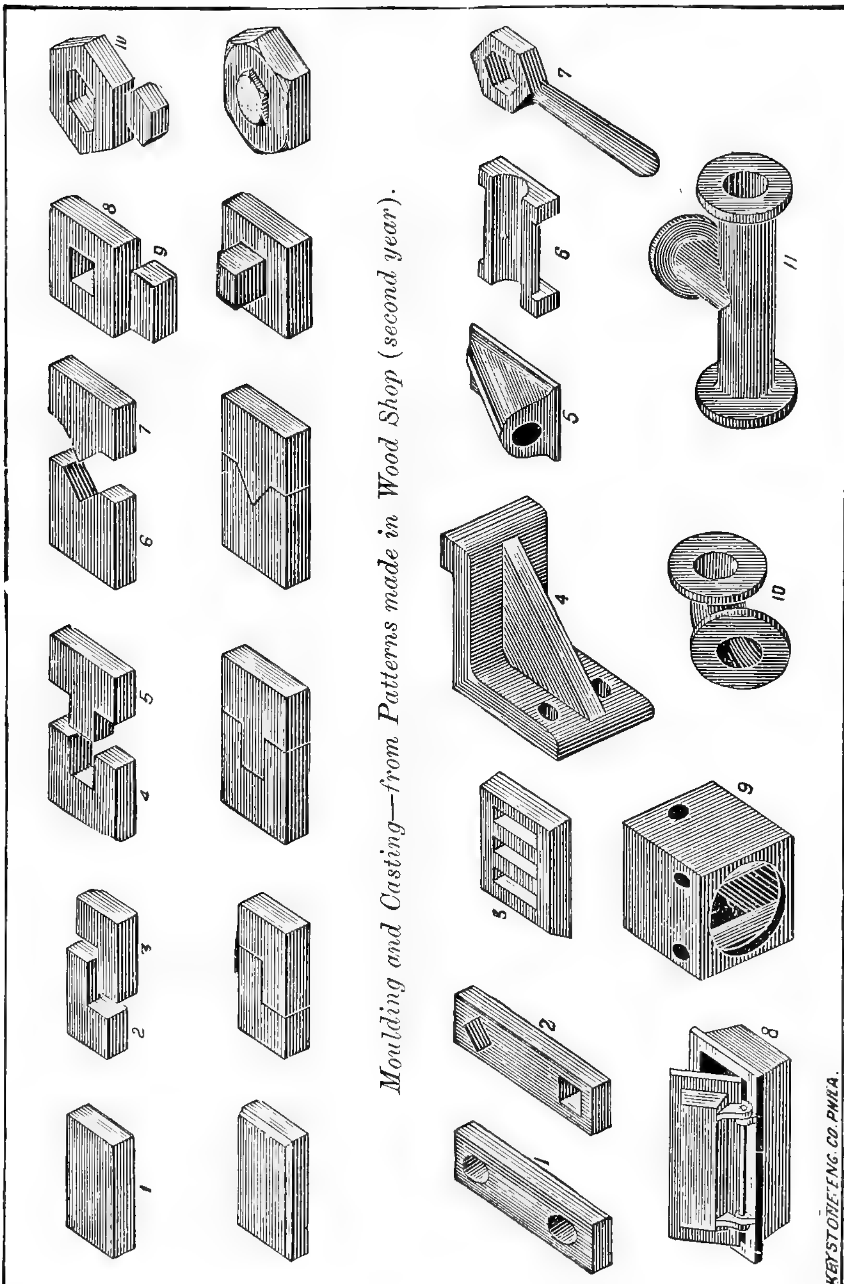
The course of work in wood and metal is shown on the following plates:

Work in Wood Shop (first year).—Joinery.



No. 1. Planing Exercise.
No. 2. Chiseling Exercise.
No. 3. Chiseling Exercise.
No. 4. Chiseling Exercise.
No. 5. Halved Corner.
No. 6. Ledge Joint.
No. 7. Slip Mortise and Tenon.
No. 8. Mitre Joint.
No. 9. Halved Corner.
No. 10. Secret Slip Mortise and Tenon.
No. 11. Dovetail, halved across.
No. 12. Square Butt.
No. 13. Mortise and Tenon.
No. 14. Dovetail Butt.
No. 15. Dovetail Brace.
No. 16. Nailing Exercises.
No. 17. Secret Dovetail.
No. 18. Dovetail Joint.
No. 19. Dovetail Joint.
No. 20. Bevel Dovetail.
No. 21. Drawer Dovetail.

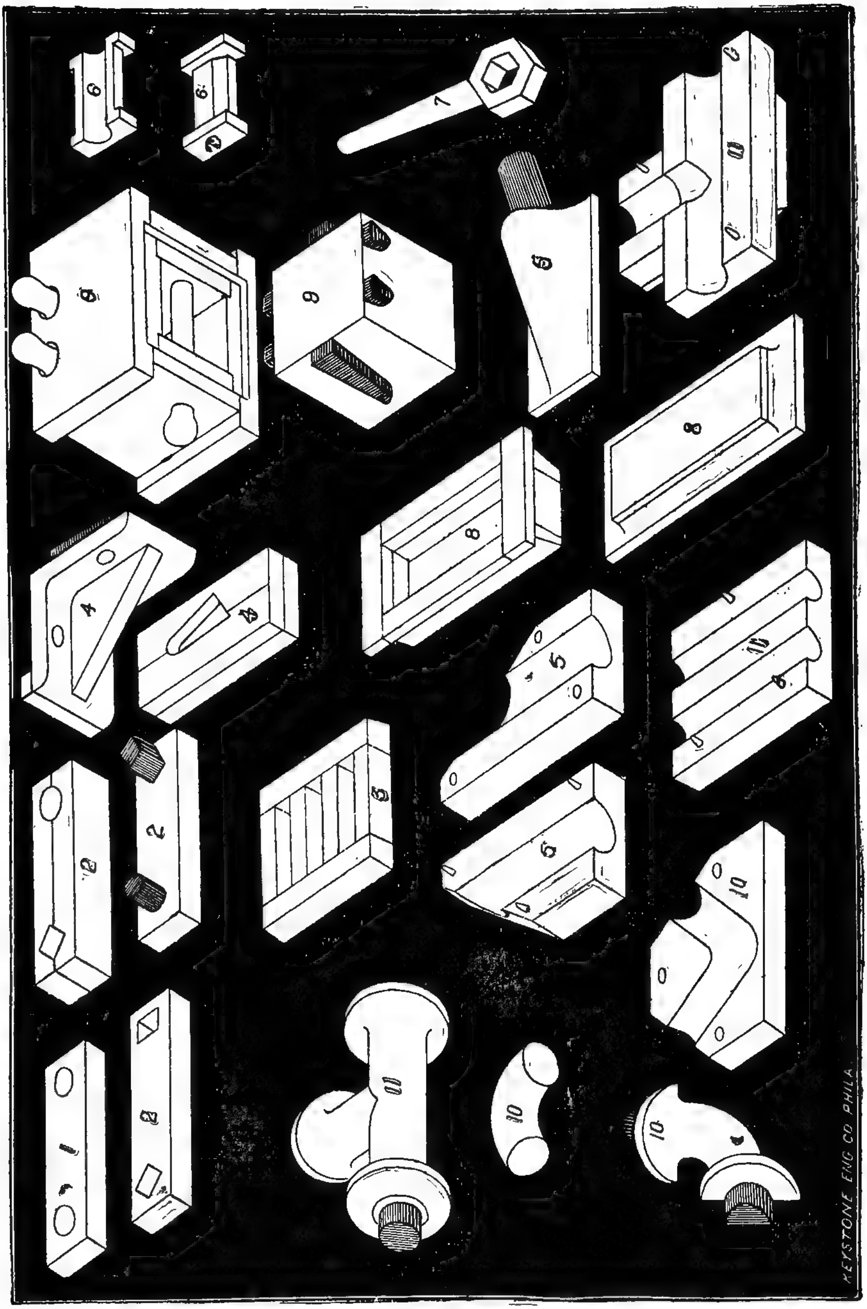
Work in Metal Shop.—Chipping, Filing and Fitting (first year).



Nos. 1-2. Washers.
No. 3. Grate.
No. 4. Bracket.
No. 5. Check Washer.
No. 6. Journal Brass.

No. 7. Wrench.
No. 8. Door and Frame.
No. 9. Hollow Cube with transverse cylinders.
No. 10. Quarter turn (pipe).
No. 11. T Joint (pipe).

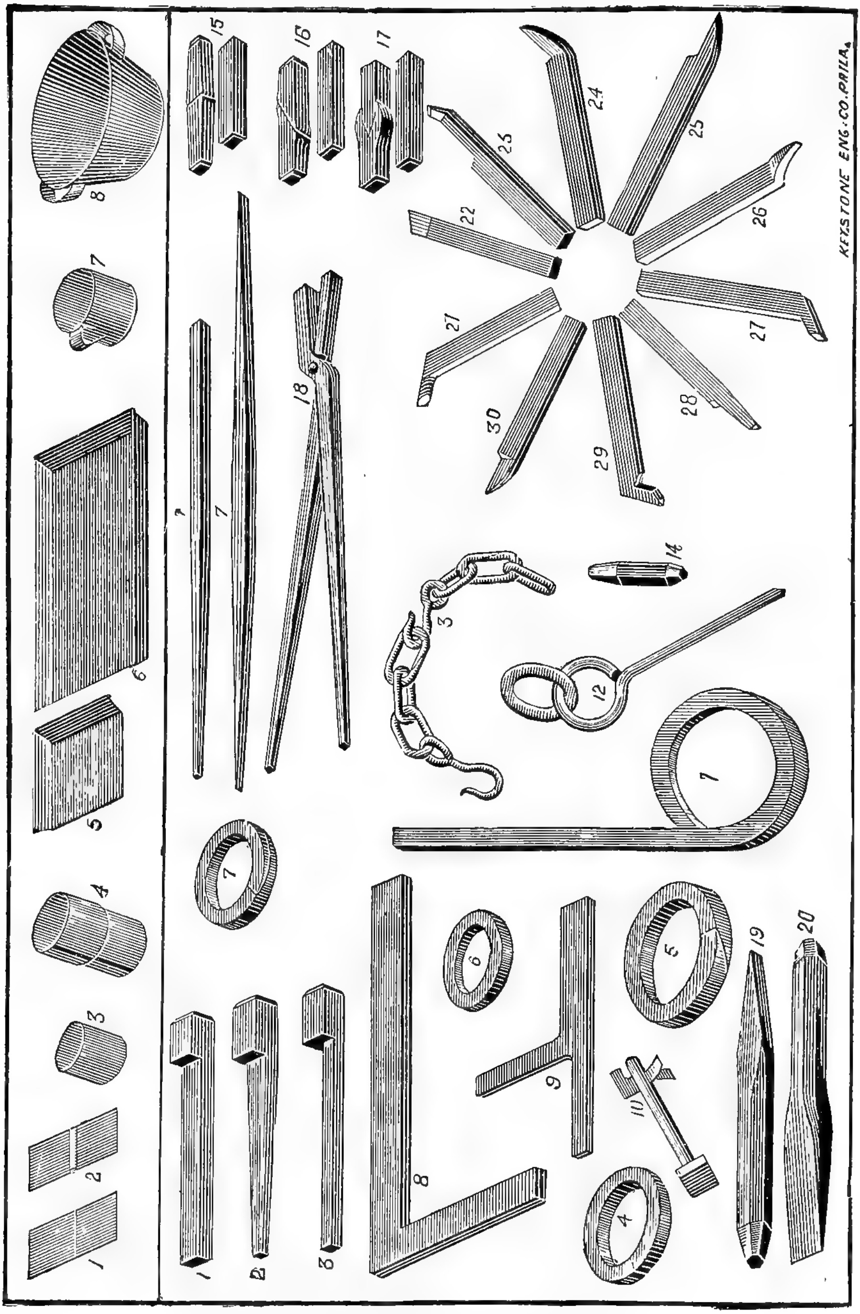
Work in Wood Shop second year.—Pattern-Making.



No. 1. Washer.
No. 2. Washer.
No. 3. Grate.
No. 4. Bracket.
No. 5. Check Washer.
No. 6. Journal Brass.
No. 7. Wrench.
No. 8. Door and Frame.
No. 9. Hollow Cube with transverse cylinders.
No. 10. Quarter Turn (pipe).
No. 11. T Joint (pipe).

Exercises in Tinsmithing (second year).

1 Soldering (plain seam). 2. Soldering (lock seam). 3-4. Pipe-Joints. 5. Corner of Seamless Pan. 6. Seamless Pan. 7. Tincup 8. Dishpan



Exercises in Forging (second year).

Nos. 1-2-3. Exercises in Drawing Out.
No. 4. Ring (butt joint).
No. 5. Ring (scarf joint).
No. 6. Seamless Ring.
No. 7. Split Ring.
No. 8. Square.
No. 9 Split Exercise.
No. 10. Bolt.
No. 11. Bolt.
No. 12. Eye Bolt and Ring.
No. 13. Chain and Hook.
No. 14. Hexagonal Plug.
No. 15. Welding (butt).
No. 16. Welding (scarf).
No. 17. Welding (split).
No. 18. Tongs.
No. 19. Cold Chisel (cape).
No. 20. Cold Chisel (flat).
No. 21-22, etc. Turning Tools.

5. **The Pennsylvania Museum and School of Industrial Art, Philadelphia.**

The Pennsylvania Museum and School of Industrial Art was incorporated on the twenty-sixth day of February, 1876, for the purpose, as stated in its charter, of establishing "for the State of Pennsylvania, in the city of Philadelphia, a museum of art in all its branches and technical applications, and with a special view to the development of the art industries of the State; to provide instruction in drawing, painting, modeling, designing, etc., through practical schools, special libraries, lectures and otherwise. The institution to be similar in its general features to the South Kensington Museum of London."

The purpose of the institution as thus defined is distinctly industrial. The collections at Memorial Hall, where the museum is located, embrace examples of art work of every description; but as the city already possesses, in the Pennyslvania Academy of the Fine Arts, an institution devoted to the advancement of the fine arts, it was determined by the founders to make the collections of the Pennsylvania Museum as largely as possible illustrative of the application of art to industry, and the instruction in the school has constant reference to a similar purpose.

The institution owes its origin to the increased interest in art and art education which was awakened by the Centennial Exhibition of 1876.

Pending the incorporation of the institution, a fund of $50,000 was subscribed, with which to make purchases at the exhibition. In the selection of objects the trustees had the benefit of the advice of the foreign commissioners to the exhibition, and in several instances the institution was the recipient of valuable gifts from individual exhibitors. Around the nucleus thus formed the museum has grown by purchase, gift and bequest to its present proportions, numbering in its collections upwards of ten thousand objects.

The major part of the collection of the products and manufactures of British India, which was shown at the Centennial Exhibition, was presented to the museum by the British government at the close of that exhibition. It occupies the whole of the west corridor at Memorial Hall.

The Moore memorial collection of objects of art, presented to the museum by Mrs. Bloomfield H. Moore as a memorial of her late husband, occupies the entire east corridor. It contains exquisite examples of lace, embroidery, fans, jewelry, pottery and porcelain, metal work, enamels, carved work in ivory and in wood, tapestries and pictures.

The museum also possesses several smaller collections, sufficiently complete in themselves to be regarded as fairly representative of the departments to which they belong. Of these, the Casper Clark collection of Persian metal work, pottery and textiles; the Vaux collection

of ancient pottery, and the Castellani collection of textiles are, perhaps, the most important.

In addition to its actual possessions, the museum is constantly receiving accessions in the form of loans of a more or less permanent character, by which the element of freshness is secured, and popular interest in the collections continually renewed.

The purpose of the school is to furnish instruction in drawing, painting, modeling, carving and designing as is required by designers, superintendents and workmen in the various constructive and decorative arts, and to serve as a training school for teachers of these branches.

It was opened during the winter of 1877–'78 in temporary rooms in industrial art hall.

The classes were very small for several years, but the attendance has increased rapidly since 1884.

Up to 1884 the work of the classes was confined to the general courses in drawing, painting and modeling, with constant regard to the needs of the industries, it is true, but without attempting to provide instruction in any of the occupations themselves, which it was hoped would be directly benefited by the training which the students received here.

The need of providing facilities for such technical instruction, however, became apparent very early in the history of the school, as it was seen that only by this means could the proper direction be given to such purely artistic training as the school had to offer, by familiarizing the students with the processes by which any industrial application of design would have to be made.

The committee desires to call especial attention to the work accomplished by the

DEPARTMENT OF WEAVING AND TEXTILE DESIGN.

The Philadelphia Association of Textile Manufacturers was formed in 1882, and among the objects for which it was specially created was the fostering of technical education. Its members represented the progressive element of the manufacturing community of Philadelphia and vicinity. These gentlemen were fully aware of the progress of technical schools for the textile arts in Germany, France and England, and were persuaded that the United States could not hope to maintain the best market for her products unless those products combined the highest skill in manufacture and the best taste in design. At that time no thorough school existed in this country, and it was necessary to begin at the foundation of the work, without previous knowledge of the exact methods to be adopted or the means to be employed to reach the desired end.

It was apparent that considerable money must be raised to properly

lay the foundation for a successful school. The sum of $50,000 was fixed upon as the minimum amount with which to inaugurate the work, and the association endeavored to obtain this sum from the manufacturers of Philadelphia by subscription; but, as with every public-spirited enterprise, a few leading men and firms bore the burden of the work, and the subscriptions finally closed at $35,000, all of which was subscribed with the understanding that no call should be made unless the entire $50,000 was secured. This sum was never reached and the whole enterprise seemed likely to be abandoned.

At this juncture a few of the individuals who had been actively engaged in the effort to raise the $50,000, despairing of success in that direction, concluded to assume the responsibility of attempting the work without the aid of any subscriptions. The project was made known to the trustees of the Pennsylvania Museum and School of Industrial Art, who very kindly placed rooms in their school building at their disposal without charge. Teachers were engaged, two Jacquard looms were ordered and a night class of enthusiastic students organized in 1883. The outfit was necessarily limited, but was increased without delay, as experience showed the needs to be supplied. Only men of acknowledged skill were engaged as teachers, a fact which greatly assisted the projectors of the enterprise and won for the school the confidence of the community.

At a meeting of the Philadelphia Textile Association held at this time the subject was again discussed, and the association decided that it would be wise to sustain the enterprise, and recommended the subscribers to the $50,000 fund to turn over the amount of their subscription to its use. Nearly $30,000 out of the original $35,000 was transferred in this way, twenty-five per cent. of which was authorized to be paid in for the use of the school in cash.

The following season President William Platt Pepper, of the Pennsylvania Museum and School of Industrial Art, undertook to raise funds for the erection of a building for the use of the school. He succeeed, within a very few days, in securing the amount needed; the building was completed in time for the new school year. The leading manufacturers of machinery responded very generously to an appeal to supply the institution with the very best machinery; and the evening class of 1884–85 was progressive and enthusiastic, acknowledging the great benefit they derived from the connection with the school.

In September, 1885, the instructors were regularly engaged to give their whole time to the school, and a day class was organized to specially prepare young men for the higher departments of their work, by means of a regular course of instruction, extending over a period of three years. The season of 1885–86 was prosperous and proved conclusively that such a school must not only be a great addition to a manufacturing community like Philadelphia, but an element of strength to the whole

country. Friends of the enterprise visited the best schools of Europe in the interest of this institution, and whenever methods were found superior to our own, they were unhesitatingly put into practice, until to-day the management feel that they are entirely ready to supply the want that has so long been pressing on the country.

It is no longer incumbent upon anyone to visit Europe for technical instruction in textile art, as this school is fully prepared to supply technical information on all subjects connected therewith: Designing, weaving, dyeing, finishing, cleansing of raw materials, all being provided for, as shown by the curriculum.

Tho school is located in the building 1336 Spring Garden street, which has been purchased by the trustees with funds provided for this purpose by the associate committee of women and adapted to the needs of the classes in the most thorough manner.

The work of each department or class is carried on in a room by itself, so that the annoyances and interruptions inseparable from the assembling of large classes and different grades of work in a common room are avoided.

The building contains a lecture room; a library and reading room; a room for elementary work from casts and models; a gallery for advanced work from the cast; one for the life class; a room for the grinding and preparation of colors; one for the work in applied design; one for modeling; one for wood carving; and a suite of rooms for the class in weaving and textile design. The chemical laboratory and dye houses are located in another building close by.

The school is under the immediate supervision and receives the active support of the associate committee of women, who act conjointly with the board of trustees in managing the affairs of the Pennsylvania Museum and School of Industrial Art. This committee now numbers thirty women.

The committee was organized in 1883 and it has (besides greatly increasing the list of members, by whose subscriptions the institution is largely supported) paid over since that time to the trustees $27,400 for carrying on the work of the school and advancing the interests of the whole institution.

REQUIREMENTS FOR ADMISSION.

Applicants for admission are expected to be as proficient in the common English branches as the completion of the grammar school course would imply. All applicants must also pass an examination in free-hand drawing. Students in the textile and chemical departments must also pass an examination in arithmetic (through percentage).

The fee for the day class in any department of the *general course* is $40 a year. Students entering for less than a year pay at the rate of $8 a month.

The fee for the evening class is $10 a year, or $5 for each term of three months.

The fee for the teachers' class is the same as that for the evening class.

In the special courses as follows:

Weaving and textile design, day class, $100 a year; evening class, $15 a year. Chemistry and dyeing, day class, $100; evening class, $15 a year. Pupils in the chemical department—day class—are required to make a deposit of $10, to cover breakage, which must be settled for semi-annually. Wood carving, $50 a year, or $10 a month.

Instruments and materials for study must be provided by the students. All articles required in any class are for sale at the school at less than retail prices, and students are expected to purchase them here.

Graduates from the regular course may continue in the school for advanced study without payment of fees, on condition that they devote a certain amount of time to teaching in the school or to other art work for the promotion of the interests of the institution.

The courses in the different departments are as follows:

GENERAL COURSE.

The general course of study embraces drawing and painting in water colors from models, casts, draperies and still life; lettering; plane and descriptive geometry; projections, with their application to machine drawing and to cabinet work and carpentry; shadows, perspective, modeling and casting; practice in the use of color, with special reference to the needs of designers—especially in textiles; historical ornament, study from the living model and original design. The instrumental drawing is taught by means of class lessons or lectures, and lectures are also given on anatomy and historical ornament, upon which examinations for certificates are based.

INDUSTRIAL DRAWING.

Class A.

EXERCISES.

Free-hand Drawing.

(1) Drawing of ornament from casts in charcoal, pen-and-ink and crayon.
(2) Model drawing in charcoal. pen-and-ink and crayon.
(3) Drawing of pieces of furniture, chairs, tables, etc.
(4) Studies of drapery in crayon. pen-and-ink, wash, etc.
(5) Studies of objects of industrial art from the museum.
(6) Studies of flowers and foliage from nature, in charcoal, pen-and-ink and water color.
(7) Lettering.
(8) Analysis of plants for the purpose of design.
(9) Original designs, from natural forms.
(10) Studies in historic ornament.
(11) Design applied to surface decoration, flat or in relief.

Instrumental Drawing.

(12) Exercises with instruments (construction of plane figures, line shading, etc.).
(13) Plans and elevations of buildings and machinery.
(14) Descriptive geometry (intersections and developments).
(15) Perspective.

EXAMINATIONS.

(1) Plane geometrical drawing.
(2) Projections.
(3) Descriptive geometry.
(4) Perspective.
(5) Model drawing.
(6) Drawing from memory.
(7) Historical ornament, a written paper, illustrated by drawings.

(This class attends lectures once a week on geometry in all its applications to drawing; and once a week on perspective, on the principles of design, on historical ornament, or some other subject directly related to the work of the class-room.)

ADVANCED DRAWING CLASS.

Class B.

This class is for the thorough study of the figure from the cast and from the living model. Students are admitted to this class only after completing the work of the preceding class A, or, in the case of those who do not desire to complete the course, or who have received their preliminary training in other institutions, on passing a satisfactory examination in drawing the human figure, either from life or from the cast.

The life class works from the draped model, and each pose is arranged with as much reference to the study, either of historical costume or of beauty of decorative effect, as of the figure itself.

This class is under the personal instruction of the principal.

DECORATIVE PAINTING AND APPLIED DESIGN.

Class C.

EXERCISES.

(1) Enlargement and reduction of colored ornament, from plates and from actual fabrics, carpets, wall papers, etc.
(2) Exercises with instruments. Drawing of geometrical patterns from plates and fabrics. (For students who have not taken the certificate of Class A.)
(3) Grinding and preparation of colors.
(4) Studies in color harmony, consisting of original designs treated in different schemes of color.
(5) Studies of plants and flowers from nature.
(6) Studies of groups, draperies, etc.
(7) Studies of objects from the museum.
(8) Original designs for painted, printed and woven ornament, lace, embroidery, etc.

EXAMINATIONS.

(1) Time sketch in water colors of flowers or a group of objects.
(2) Exercises in color harmony, in water colors.
(3) Paper on the origin and chemistry of pigments.
(4) Paper on principles of design in surface decoration.

(5) Description of lithography, engraving and etching, porcelain and pottery decoration, fresco painting, mosaic work, inlays, colored glass work.

(This class attends the lectures on harmony of color, on historical ornament and on principles of decorative design.)

MODELING CLASS.

Class D.

EXERCISES.

In Clay.

(1) Studies of ornament from casts.
(2) Studies of details of human figure from casts.
(3) Studies of animal from casts.
(4) Studies of ornament from prints and photographs.
(5) Studies of the living model.
(6) Original designs for wood or stone carving, and for stucco work.
(7) Original designs for ornament in terra cotta.

TEACHERS' CLASS.

(For those employed as teachers in either public or private schools.)

EXERCISES.

Free-hand Work.

(1) Drawing of ornament from the cast.
(2) Drawing from models.
(3) Drawing pieces of furniture, as chairs, tables, etc.
(4) Foliage from nature.
(5) Analysis of plants for the purpose of design.
(6) Elementary design.
(7) Studies of historic ornament.
(8) Applied design.
(9) Drawing from dictation.
(10) Modeling, with special reference to the work of the kindergarten.

Instrumental Work.

(11) Plane geometrical drawing.
(12) Elements of projection.
(13) Elements of perspective.

Examinations.

(1) Model drawing.
(2) Drawing from dictation.
(3) Plane geometrical drawing.
(4) Elements of projection.
(5) Elements of perspective.
(6) Drawing on the blackboard.

TEACHERS' CLASS.

(For those employed as teachers in either public or private schools.)

EXERCISES.

Free-hand Work.

(1) Drawing of ornament from the cast.
(2) Drawing from models.
(3) Drawing pieces of furniture, as chairs, tables, etc.

(4) Foliage from nature.
(5) Analysis of plants for the purpose of design.
(6) Elementary design.
(7) Studies of historic ornament.
(8) Applied design.
(9) Drawing from dictation.
(10) Modeling, with special reference to the work of the kindergarten.

Instrumental Work.

(11) Plane geometrical drawing.
(12) Elements of projection.
(13) Elements of perspective.

Examinations.

(1) Model drawing.
(2) Drawing from dictation.
(3) Plane geometrical drawing.
(4) Elements of projection.
(5) Elements of perspective.
(6) Drawing on the blackboard.

This course is arranged for the benefit of those who, while unable to devote as much time to the work of this school as would be required to complete the regular course covered by the certificate, are yet desirous of properly qualifying themselves either to teach drawing in any elementary school or to make a good use of the blackboard in teaching other branches.

Especial attention is paid to this last consideration, and classes in blackboard work, under the personal instruction of the principal, meet every Tuesday afternoon for just such practice as is particularly desired by kindergarteners and primary school teachers.

DEPARTMENT OF WEAVING AND TEXTILE DESIGN.

COURSE OF STUDY.

Day Class—Requiring a three years' attendance at school.

FIRST YEAR'S COURSE.

A general study of nature of materials used in weaving textile fabrics, explanation of the necessary materials and instruments used by designers.

Drawing-in of harness—Straight draws; broken draws; point draws; section draws; straight double draws; mixed or irregular draws.

Reeds and reed calculations.

Dressing of warps, and calculations for same; beaming.

WEAVES.

A.—Ground or Foundation Weaves.

I. The hand loom analyzed and explained.

II. Plain or cotton weave and fancy figuring through color arrangements in warp and filling, for light weight fabrics.

III. Twill weaves—*a*, one-sided twills; *b*, even-sided twills; and fancy figuring with same through color arrangements in warp and filling.

IV. Satin weaves—*a*, single satins; *b*, double satins; *c*, figuring in single satins.

B.—Drafting Weaves.

Lectures on same, with practical examples and rules to be observed.

C.—Derivative Weaves.

Basket weaves; rib weaves; granite weaves; steep twills; curved twills; Brocken twills; skip twills; corkscrew twills; fancy twills; pointed twills and honeycomb weaves; pique weaves and combinations of miscellaneous weaves through combintion for single fabrics, two or more classes from the above.

Standard sizes of cotton, wool and worsted yarns, and calculations with the same.

Picking out samples of fabrics constructed on single weaves, and methods and rules for calculating used in duplication.

Original weaves and complete orders for manufacturing the same, composed by each scholar.

Instrumental Drawing.

Exercises with instruments; construction of plane figures; line shading, etc.

Free-hand Drawing.

Enlargement and reduction of designs; analysis of plants for the purpose of using design for textile fabrics; work in color; lectures on color harmony.

SECOND YEAR'S COURSE.

Power looms analyzed and explained.

Practical weaving and fixing; *a*, the Thos. Wood roller loom for ginghams, shirtings, cottonades, dress goods, etc.; *b*, the Crompton loom, and *c*, the Knowles loom for worsted and woolen fabrics of every description; single and double beam work.

Double cloths—Study of the best methods of combining different weaves, as: Designs backed with weft; designs backed with warp; designs backed with warp and weft; designs for double cloth double faced.

Calculations: ascertaining the cost of production, etc., of different fabrics.

Analyses of single (fancy) and double cloth fabrics, and reproduction with various changes, as indicated by instructor.

The Jacquard machine analyzed and explained; principles of construction and method of operatien of the single-lift machine; the various modifications, such as double-lift single cylinder, double-lift double cylinder; laying out of comber boards, and figuring for various changes in texture; tying up of harness for single cloth.

The Bridesburg clipper loom analyzed and explained, and practical work with it, with special reference to its use in connection with the double-lift double cylinder Jacquard machine for damask table covers, etc.

Card stamping machine (French index) analyzed and explained.

Practical work for single cloth.

Card lacing explained and practiced.

Designing paper with reference to the different kinds of textile fabrics.

Sketching of designs and transferring from sketch to designing paper.

Methods of tying up Jacquard harness.

Changing of textures on Jacquard looms.

Shading of weaves in different Jacquard work.

Analysis of Jacquard work by picking out of textures and by sketching the design.

Special study of Jacquard work for the following textile fabrics: Damask towel, table cloth, dress goods, two-ply ingrain carpet, three-ply ingrain carpet, upholstery, carriage covers, cloakings, dress trimming, fringes, Marseilles quilts, etc.

Study of processes for textile fabrics before and after weaving.

Instrumental Drawing.

Plans for machinery, mill buildings, etc.
Illustrating processes of weaving.
Illustrating sectional cuts of textile fabrics, etc.

Free-hand Drawing.

Sketching for the different fabrics on Jacquard work.

(*For work in Chemistry required in this class, see page 42.*)

THIRD YEAR'S COURSE.

The two-ply ingrain carpet machine analyzed and explained.
The ingrain carpet hand loom and the Murkland power carpet loom analyzed and explained.
Practical work with these looms.
Card stamping machines (American index) analyzed and explained.
Practical work with these machines.
Tying up of Jacquard harness (French index) machines for double cloth—three and four-ply fabrics.

Advanced Work for Harness Loom.

Study of cut pile fabrics—velvets, plush, etc.
Study of Terry pile fabrics—*a*, with wires; *b*, without wires.
Study of tapestry and Brussels carpets; double-faced Brussels carpet; Terry and velvet combined in Brussels carpets.
Astrakans—*a*, cut; *b*, uncut; *c*, figuring in Terry and velvet principle.
Chenille—Rugs, curtains, etc.
Gauze fabrics—*a*, plain; *b*, figured; *c*, combined with other fabrics.
Instrumental and free-hand drawing similar to second year's course, but more advanced.

DEPARTMENT OF CHEMISTRY AND DYEING.

Schedule of Studies.

FIRST YEAR.

First Term.

General chemistry lectures.
General chemistry laboratory work.

Second Term.

General chemistry lectures.
Qualitative analysis lectures.
Qualitative analysis laboratory work.
Special methods.

SECOND YEAR.

First Term.

Volumetric analysis lectures and laboratory work.
Gravimetric analysis.
Industrial chemistry lectures and laboratory work.
Scouring.
Bleaching.
Dyeing, etc.

Second Term.

Industrial chemistry lectures and laboratory work.
Dyes.
Mordants.
Fast colors.
Dyeing.
Finishing, etc.

COURSE IN CHEMISTRY AND DYEING.

This department was organized in the fall of 1887 and owing to an insufficiency of room in the school building accommodations were obtained at the south-east corner of Broad and Spring Garden streets, a few doors from the main building. A large laboratory has been fitted up with accommodations for some thirty (30) students, and is well supplied with the apparatus, chemicals and dyestuffs necessary for carrying on experimental work in chemistry, and in dyeing and finishing different fabrics. There is also a small dye-house in which the yarn used by the weaving department is cleansed, bleached and dyed, and in this way the students obtain a practical knowledge of the art of dying. The department is primarily designed to give the student that practical knowledge of the subject which will enable him to avoid the errors so often made by those who have no such knowledge, and also to so train his powers of observation that he will be enabled to detect and overcome faults in the various methods, used in the textile industries.

With this object in view the regular day students commence the study of general chemistry in the second year. Lectures and oral exercises are given in the class-room, and these are supplemented by work in the laboratory. Each student is supplied with a desk and the apparatus necessary for carrying on a sufficient number of experiments to demonstrate clearly the general principles of chemistry, with especial reference to its practical application to the textile industries. The student is encouraged to make original research of the various methods used in chemical and manufacturing work with the object of improving them if possible; and as this is done under the eye of an instructor, who is careful to correct any wrong conclusions, the student is so trained in his faculty of observation that when future difficulties arise he will be able to overcome them.

In the second term the study of chemistry is continued by means of lectures, and in the laboratory the student commences the work of qualitative analysis, which is continued through the term.

Lectures are also given on this subject and especial attention is paid to the analysis of those chemicals and dyestuffs most commonly used. Also to the methods of detecting the dyes present on fibers and the mordants used. The laboratory instruction is supplemented as far as possible by excursions to manufacturing and chemical establishments where the processes conducted on a large scale can be seen in practical operation.

In the second year a brief course in quantitative analysis is taken up and various methods of both volumetric and gravimetric analysis are taught. This includes the methods used for testing acids, alkalies, various chemicals, dyestuffs and mordants, such as sumac, indigo, tartar emetic, etc.

The study of industrial chemistry is then taken up and carried on for the remainder of the year. Lectures are given on the methods of manufacturing various chemicals and dyes. The different materials used in textile industries, as cotton, wool, silk, jute, flax, etc., are considered and the differences between them and their behavior toward chemicals and dyestuffs carefully explained. Having studied the raw materials, the different processes to convert them into finished cloth are taken up systematically and the faults met with in each explained.

Taking for example the wool fiber, its source is first considered and then the variations occurring in it, due to differences in climate, breed of sheep and portion of the body from which the fiber is taken.

The method of scouring and the processes of carding and spinning, etc., are thoroughly studied.

The various conditions in which wool is dyed, as in the raw state, or in the form of yarn, or as woven into cloth, are next taken up and the methods used in each given.

And finally the methods of finishing the woven cloth are considered.

LABORATORY WORK.

Particular attention is paid to the work of the students in the laboratory in connection with the lectures, and each student is obliged to carry on experimental work in the methods used for determining the various materials employed, whether cotton, wool, silk, etc , and especially to detect them when mixed together in cloth or yarn. He then takes up each material and carries on the processes of cleansing, bleaching and dyeing.

The action of the different mordants on the various dyes is considered and their effect on the shade as well as on the fastness of the color determined. A great deal of attention is paid to the methods of dyeing fast shades, and the process of testing dyed fabrics as to the fastness of their colors toward light and scouring is carried out.

Besides the experimental work in the small way there is also a dyehouse connected with the laboratory in which the students dye the yarn used in the weaving department, and in this way a practical, knowledge is obtained of the subject. During the past year the students have taken yarn in the grease and carried out the entire process of scouring, dyeing and weaving it into cloth original in color and design so that the entire work from the yarn in the grease to the woven cloth is now carried on at the school.

CARVING CLASS.

Course of Study.

(1) Selection, sharpening and care of tools.
(2) Bosses and scrolls from casts and models.
(3) Intaglios and mold sinking.
(4) Ornament from prints and drawings.
(5) Original designs for panels, carved enrichments for furniture and cabinet work, picture frames, easels, etc.

Lectures.

Lectures on the anatomy of the human and of the animal form as applied to decorative art, on harmony of color and related subjects are given throughout the year.

Class instruction in the geometrical branches is given every Monday, which all students are expected to attend; and lectures on original design, on art history and on perspective are given by the principal every Wednesday morning from eleven o'clock to half-past twelve, and every Thursday evening. All first-year students are expected to attend these lectures.

Evening Classes.

These are held on Monday and Wednesday evenings from 7.30 to 9.30 o'clock, from October 9th until the middle of April.

The course consists essentially of the same topics as are taken up by the day classes. A full course of lectures is given on chemistry, and laboratory work is devoted almost entirely to experimental work in cleansing, bleaching and dyeing different fabrics. The full course covers two years and is divided as follows:

FIRST YEAR.

The general principles of chemistry are introduced by a series of lectures and experiments. At the same time work is commenced in the laboratory and some chemical experiments carried on by each student. The study of the different fibres follows and the methods of detection in mixed goods; the best mode of cleansing, bleaching and dyeing are given, and then the methods of finishing the woven cloth in order to obtain the best results.

In connection with lectures on these subjects, the student carries out experiments in the laboratory on small samples and new dyestuffs, or methods are tested and their utility or uselessness shown.

SECOND YEAR.

In the second year the study of qualitative and also quantitative analysis, including both volumetric and gravimetric analysis, is briefly considered, and the methods of testing acids, alkalies and various chemicals in common use in the dye house are given. The study of

dyeing and finishing is continued with especial reference to fast colors and such shades as give the most trouble in the dye-house. New dyes and processes are tested, and opportunity and assistance is given any student desirous of making special research of subjects directly appertaining to his line of business.

OTHER SPECIAL COURSES.

Special courses in wood carving, tapestry painting and other branches can usually be arranged to suit the convenience of the pupil, the fees being the same as the monthly fees for the regular course.

6. Lehigh University.

The Lehigh University at Bethlehem, Pa., was founded by the Hon. Asa Packer, who, during the year 1865, appropriatnd the sum of five hundred thousand dollars, to which he added one hundred and fifteen acres of land in South Bethlehem to establish an educational institution in the valley of the Lehigh. It was incorporated by the Legislature of Pennsylvania in 1886. In addition to these gifts made during his lifetime, Judge Packer by his last will secured to the university an endowment of $1,500,000.

"The original object of Judge Packer was to afford the young men of the Lehigh Valley a complete technical education for those professions which had developed the peculiar resources of the surrounding region. Instruction was to be liberally provided in civil, mechanical and mining engineering, chemistry, metallurgy, and in all needful collateral studies. French and German were made important elements in the collegiate course. A school of general literature was part of the original plan, together with tuition in the ancient classics."

ADMISSION.

All candidates for admission must be at least sixteen years of age and must satisfactorily pass examination in the following subjects:

English grammar; geography, general and political; history of the United States, including the Constitution; arithmetic; algebra (Olney's university algebra is recommended, as it is the text-book used in the university); geometry (Chauvenet's geometry, six books).

Elementary physics is required in addition to the above for admission to the course in mechanical engineering.

Candidates for admission to advanced studies *in any course* are required to pass, *in addition to the entrance examinations for that course*, examinations in the work already done by the classes which they desire to enter.

Tuition is free in all branches and classes.

COURSES OF STUDY.

Two schools are included in the university, viz: The school of general literature which comprises,

I. The classical course or course in arts.
II. The Latin-scientific course or course in philosophy.
III. The course in science and letters.

and the school of technology which comprises,

I. The course in civil engineering.
II. The course in mechanical engineering.
III. The course in mining and metallurgy.
IV. The course in electrical engineering.
V. The course in chemistry.

" The object of the course in mechanical engineering is the study of the science of mechanics; the principal subjects are: the nature, equivalence and analysis of mechanisms, the mechanics or theory of the principal classes or types of machinery, mechanical technology and the principles and practice of machine design.

" That the students may obtain the practical engineering data which they will most need when beginning their work as mechanical engineers, they are required to pursue a course of shop instruction which does not necessarily involve manual labor and manipulation of tools, but is principally devoted to familiarizing them with those points in patternmaking, molding, forging, fitting and finishing, which they need to know as designers of machinery. Particular attention is therefore directed to the forms and sizes of machine parts that can be readily constructed in the various workshops, to the time that it takes to perform, and the order of the various operations to the dimensions most needed by workmen and to the various devices for increasing the accuracy of the work, durability of the parts and convenience of manipulation. This involves acquaintance with the processes and machinery of the workshop, but it is the foreman's and superintendent's knowledge which is required, rather than the manual dexterity and skill of the workman and tool hand. The acquirements peculiar to the latter are by no means despised, and the students are encouraged to familiarize themselves therewith during leisure hours, but manual work in the shops forms no regular part of the course. On the contrary, the student enters the shop with hands and mind free to examine all the processes, operations and machinery, and is ready at the call of the teacher to witness any operation of special interest. Provided with note book, pencil, calipers and measuring rule, the student sketches the important parts of the various machine tools, notes down the successive steps of each of the important shop processes as illustrated by the pieces operated upon, and follows pieces of work through the shops from the pig or merchant form to the finished machine.

That the students may learn to observe carefully, and be trained to think and observe for themselves in these matters, there is required of them a full description of the various processes, operations and tools involved in the production of each one of a series of properly graded examples of patterns, castings, forgings and finished pieces which are not being constructed in the shops at the time and the blue prints for which have been given to them on entering the shops. The student's work is directed not only by these drawings and by the printed pro gramme given him at the start, but also personally by a teacher, who accompanies him into the shops, gives necessary explanations, and tests the strength and accuracy of his knowledge bv examining the sketches and notes and by frequent questioning. Finally the results of the observations and the sketches are embodied in a memior.

"During the course there are frequent visits of inspection to engineering works, both in and out of town, with special reference to such subjects as machine elements, prime movers, machinery for lifting, handling and transporting, and machinery for changing the form and size of materials. It is intended that each of these excursions shall have some definite purpose in view, which must be fully reported upon by the students.

"The instruction in machine design, during the second term of the junior year, consists in determining rational and empirical formulas for proportioning such machine parts as come under the head of fastenings, bearings, rotating, sliding and twisting pieces, belt and toothed gearing, levers and connecting rods; also in comparing recent and approved forms of the same parts with respect to their advantages as regards fitness, ease of construction and durability, and in making full-sized working drawings of these parts. All the dimensions are determined by the students from the above mentioned formulas, the data being given as nearly as possible as they would arise in practice. During the senior year the students undertake the calculations, estimates and working drawings involved in the design of a simple but complete machine, each student being engaged upon a different machine. From the finished drawings of each machine tracings are made and then blue prints taken for distribution among the other members of the class. The whole class also take up the design of a steam engine, every dimension being determined by the students, and complete working drawings made. In the case of the simple machines and of the steam engine the general plan of arrangement is given to the students in the form of rough sketches, photographs or wood cuts. This work continues to the middle of the last term of the senior year. From this time on the students are expected to make original designs for simple mechanisms, whose object has been fully explained. Throughout the course the work in the draughting room is carried on as nearly as possible like that of an engineering establishment, and special attention

is paid to methods of expediting the work of calculation by means of simple formulas, tables and diagrams.

The graduate in this course receives the degree of Mechanical Engineer (M. E.).

The course, in detail, is as follows:

FRESHMAN CLASS.

(*Figures indicate hours per week.*)

Second Term.

Mathematics.—Olney's university algebra, part III (3). Plane and spherical trigonometry and mensuration; use of logarithmic tables (2).
German.—Grammar and exercises (continued); Joynes' Otto's reader; translations (3). Or *French.*—Grammar; Keetle's reader; translations (3)
Drawing.—Projection drawing and descriptive geometry (3). Free-hand drawing (2).
English.—Exercises and declamations (2).
Gymnasium (2).

SOPHOMORE CLASS.

First Term.

Mathematics.—Analytical geometry; Olney's general geometry (4).
Physics.—Mechanics, heat and electricity; lectures (5).
Drawing.—Isometrical drawing; architectural drawing (2).
Visits of Inspection.—Shops of the vicinity (2).
German.—Grammar; exercises; translations; readings (2). Or *French*—Grammar; Chardenal's exercises; readings; translations (2).
English.—Exercises and declamations (1).
Gymnasium (2).

Second Term.

Mathematics.—Differential and integral calculus, Olney (4).
Physics.—Sound, light and meteorology; lectures (3).
German.—Grammar; exercises; systematic readings; translations; dictation (2). Or *French.*—Grammar; dictation; Chardenal's exercises; O'Connor, Choix de Contes Contemporains (2).
Mechanics.—Mathematical theory of motion; science of motion in general; statics; dynamics and statics of fluids; lectures on theory of center of gravity and moment of inertia (4).
Steam Engine.—Rigg's practical treatise (3).
Essays and Declamations (1).
Gymnasium (2).

JUNIOR CLASS.

First Term.

Mathematics.—Integral calculus, Courtenay (2).
German.—Systematic readings; translation; dictation; compositions (2). Or *French.*—Translations; readings; contemporary authors; Saintsbury. Specimens of French literature (2). Conversation class in both languages optional.
Mechanical Technology.—Shop instruction; examination of the processes and appliances involved in patternmaking, molding, forging, fitting and finishing, with sketches and reports (7).
Boilers.—Wilson; strength, construction and wear and tear of boilers (1).
Strength of Materials.—Elasticity and strength of wood, stone and metals; theory of beams, shafts and columns; reports on experimental tests (4).
Literature and History (1).
Gymnasium (2).

Second Term.

German.—Systematic readings; compositions; lectures on German literature (2). Or *French.*—Reading; dictation; compositions; lectures on French literature; conversation class in both languages optional (2).
Kinematics of Machinery.—Reuleaux; nature and equivalence of mechanism (3).
Machine Design.—Proportioning of such machine parts as come under the head of fastenings, bearings, rotating and sliding pieces, belt and toothed gearing, levers and connecting rods (5).
Metallurgy.—Metallurgical processes; furnaces; refractory building materials; combustion; natural and artificial fuels; metallurgy of iron (4).
Machinery of Transmission.—Weisbach-Herrmann (2).
Essays and Original Orations.
Gymnasium (2).

SENIOR CLASS.

First Term.

Thermodynamics.—General principles; application to steam engines and air compressors (3).
Graphical Statics.—Graphical analysis of roof trusses and girders (2).
Machine Design.—Calculations and working-drawings for a high-speed steam engine (4).
Kinematics.—Diagrams of the changes of position, speed and acceleration in mechanisms; link and valve motions; quick return motions; parallel motions; laying out cams (3).
Mechanics of Machinery.—Weisbach-Herrmann; hoisting machinery, accumulators, cranes and locomotives (4).
Gymnasium.

Second Term.

Mechanics of Machinery.—Weisbach-Herrmann; pumps, pumping engines, blowing engines, compressors and fans (4).
Machine Design.—Calculations and working-drawings for the following machines: Drilling, shaping, milling, shearing and punching machines, hoists, pumps and stone crushers; original designs (5).
Hydraulics.—Hydrostatics; flow of water in pipes and channels; hydraulic motors (2).
Measurement of Power.—Indicating of steam engines; determination of evaporative efficiency of boilers; dynamometer experiments (1).
Lectures on American and English Literature (2).
Christian Evidences.—Lectures (1).
Preparation of Thesis.
Gymnasium.

7. The Pennsylvania State College.

The Pennsylvania State College was opened to students in 1859, as an agricultural manual labor school. Subsequently it received the benefit of the land grant act of 1862, which gives "the mechanic arts" an equal place with agriculture among its leading objects. The general plan of organization is to make the studies of the first two years substantially alike for all students, and then to provide a number of special and technical courses on the foundation thus laid. In this way the college now maintains advanced courses in General Science, Agriculture, Chemistry, Physics and Electrotechnics, Civil Engineering and Mechanical Engineering, besides a more elementary course in Mechanic Arts.

MECHANIC ARTS.

This course went into full operation in September, 1884. A substantial and attractive new building was opened February 10, 1886, and is admirably adapted to its purpose, except that the recent rapid increase in the number of students has already outgrown its capacity. The course is designed to afford such students as have had the ordinary common school education an opportunity to continue the elementary scientific and literary studies, together with mechanical and free-hand drawing, while receiving theoretical and practical instruction in the various mechanical arts.

The instruction in shop work is given by means of exercises so planned as to cover, in a systematic manner, the operations in use in the various trades.

The object of the course being to give instruction in the use of tools, only such constructions are made as cover principles without undue repetition.

The first instruction in carpentering and joining is in the use of the saw and plane in working wood to given dimensions, and a series of elementary exercises follow in order, such as practice in making square joints, different kinds of dovetails, the various tenons, roof-trusses, panels, etc.

The instruction in turning and circular-section patternmaking is given from a series of models; also, bench patterns are made for subsequent use in the foundry.

The foundry course consists in casting from the patterns which the student himsels has previously made. Many of the pieces cast from these patterns are used in his clipping and filing work.

In the forge shop are taught the management of the fire and the degree of heat necessary to forge the different metals.

Drawing, forming, bending, upsetting, fagoting, splitting, punching, chamfering, annealing, tempering, case-hardening, etc., are taught by means of a series of exercises in which the elements of the iron-forger's art are particularly dwelt upon. Every piece is made to certain dimensions laid down upon the drawing, the article being forged before the class by the instructor, who directs attention to the essential feature of the operation, which is then repeated by each student.

The course in vise work includes filing to line, filing to template, free-hand filing, fitting, and chipping straight and grooved surfaces in cast iron, wrought iron and steel.

In the machine shop the student, after having the lathe and its mechanical construction explained to him, is taught centering, tape-turning, chucking, reaming, inside and outside screw-cutting, bolt-turning, etc. He is then required to construct some piece of mechanism in which many of these principles are involved.

DRAWING.

Drawing extends through the entire three years.

This work is looked upon as of the highest importance, and the effort is to make the instruction thorough, practical and of direct utility. Considerable time is devoted to free-hand drawing, as it is believed that it not only assists in mechanical drawing, but is of great service in after years, whatever the occupation chosen.

The mechanical drawing consists of a series of exercises, and such are selected as will be of subsequent use. They are arranged in progressive order, beginning with geometrical constructions involving straight lines and circular arcs only, and ending with the more complex curves, such as the ellipse, helix, epicycloid, etc.

Projection is next taken up. The instruction in this is from models, so that the student may have before him the actual object from which the projection is made, and not be obliged to depend upon his unaided conception. After completing this work he is required to draw parts of machines from actual measurements. For this purpose he is given some piece of mechanism to sketch and measure, and of which, finally, he is to make complete working drawings.

The mathematical instruction of the course covers algebra, plane and solid geometry, plane and spherical trigonometry and land surveying, taught with special reference to this class of students, many practical applications being made. At present the department is well equipped, but additions of machinery are being made, from time to time, to meet the requirements of the course.

MECHANICAL ENGINEERING.

The object of this course is to prepare students in those subjects which will enable them to design machines or plants of machinery upon scientific principles.

The instruction is given by means of lectures and recitations, with practice in the shops and laboratories. It treats of the mechanical properties of materials, of the motions and efficacy of machines, of the production, measurement and distribution of power.

Excursions are occasionally made in order that students may witness running machinery, methods of carry power, arrangement of shafting, and manufacturing processes.

The study of steam engineering involves the principles and applications of thermodynamics, the characteristics and use of different fuels, the generation of steam with the construction of generators, and the mechanism and efficiency of the various steam engines. Students are also required to design different forms of valve gearing from data given them.

Instruction is given on hydraulic motors, windmills, pumps, air engines and other machines.

Drawing is carried on in connection with recitations. It includes sketching machines and drawing to scale from those sketches, making detail and sectional drawings, and designing machines, thus applying the principles and knowledge acquired in the class room. The entire work is made as practical as is consistent with a thorough theoretical training. A course in shop work is required, besides the experimental work with boilers, indicators, inspirators, governors, testing strength of materials, etc. At the close of the course each student presents a thesis, in which he is to give evidence of his efficiency by explaining and illustrating some work of original research, or by designing and describing with plates some piece of mechanism.

The courses are outlined as follows:

COURSE OF MECHANICS ARTS.

Years.	Session.	STUDIES.	Hours per week.	SHOP-WORK AND DRAWING.	Hours per week.
FIRST YEAR.	Fall.	United States History, . . Arithmetic, ... English Grammer, . . .	3 4 5	Carpentering, ... Geometrical Free-hand-Drawing, ...	4 5
	Winter.	Algebra begun, ... English Composition, . . United States History, . .	5 5 5	Carpentering and Joining, Model and Object Drawing, ...	8 5
	Spring.	Algebra, ... English Composition, . . Book-keeping, ...	5 5 4	Wood-turning, ... Designing, ...	6 5
SECOND YEAR.	Fall.	Geometry, ... Algebra, ... Physics, ...	2 4 4	Patternmaking, ... Geometrical Drawing, .	4 4
	Winter.	Geometry, ... Algebra, ... Physics, ... English, ...	2 4 4 2	Foundry Work, ... Orthographic Projection and Intersections, . . .	8 5
	Spring.	Geometry, ... Algebra, ... Mechanics, ... Civil Government, . . .	4 5 3 2	Forging, ... Development of Surfaces and Isometric Perspective, ...	8 6
THIRD YEAR.	Fall.	Algebra, ... Geometry, ... Mechanics, ...	4 3 4	Forging, ... Linear Perspective and Shades and Shadows, .	6 9
	Winter.	Geometry, ... Trigonometry, ... Rhetoric, ...	3 3 4	Vise Work, ... Detail Drawing, ...	6 9
	Spring.	Trigonometry and Surveying, ... Mechanicism, ...	5 3	Machine Tool Work. Machine Designing.	

It will be seen that the shop work in the mechanical engineering course is very similar to that required of the students in the elementary mechanic arts course. There is, however, this difference: In the last year of the advanced course, the shop work is almost entirely machine construction of the student's own designing. Besides this, testing the strength of materials, experimental work with boilers, inspirators, governors, indicators, etc., is a prominent feature of their work.

COURSE IN MECHANICAL ENGINEERING.

FRESHMAN CLASS.

Fall Session.—Algebra, (4); Geometry, (2); German, (5); History, (4).
Practicums.—Drawing, Geometrical and Projection, (4); Carpentry, (4).

Winter Session.—Trigonometry, (2); Geometry, (4); Rhetoric, (4); German, (5).
Practicums.—Drawing, Intersections, (2); Carpentry, (6).

Spring Session.—Trigonometry, (5); Physiology, (3); German, (5); Tactics, (2).
Practicums.—Drawing, Intersections and Developments, (4); Wood-turning, (4).

SOPHOMORE CLASS.

Fall Session.—Analytic Geometry, (4); Chemistry, (4); German, (2); French, (3); History, (2); Surveying, (1).
Practicums.—Surveying, (4); Chemistry, (4).

Winter Session.—Analytic Geometry, (4); Chemistry, (4); German, (2); French, (3); History, (2).
Practicums.—Chemistry, (8); Patternmaking, (2).

Spring Session.—French, (3); Differential Calculus, (4); Descriptive Geometry, (4); Mechanics of Machinery, (5).
Practicums.—Mechanism, (6); Drawing, Descriptive Geometry, (4).

JUNIOR CLASS.

Fall Session.—Physics, Mechanics and Heat, (4); Descriptive Geometry, Maps, Shades, Shadows, etc., (4); Integral Calculus, (3); Mechanics of Machinery, (4).

Winter Session.—Analytical and Graphical Statics, (4); Physics, Electricity, (4); Materials of Construction, (3); Determinants, (2); Valve Gearing, (2).
Practicums.—Physics, (4); Forging, (6).

Spring Session.—Kinetics and Kinematics, (4); Quarternions, (4); Materials of Construction, (3); Physics (4).
Practicums.—Chipping and Filing, (6); Mineralogy, (4).

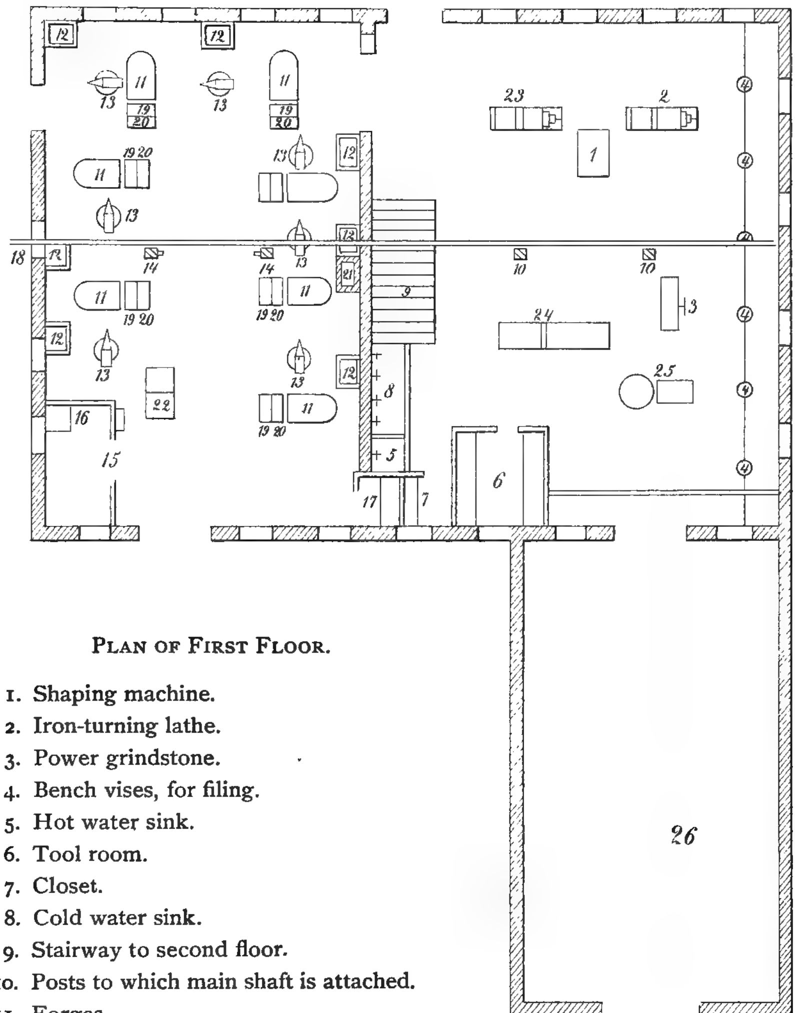
SENIOR CLASS.

Fall Session.—Thermodynamics, Lectures, (3); Statics of Machinery and Lubricants, (4); Geology, (4); Political Economy, (4).
Practicums.—Mechanical Drawing, (6); Engine Lathe Work, (6).

Winter Session.—Machine Design, (3); Steam and Steam Engines, (4); Experimental work with Indicators, Injectors and Governors, (2); Constitutional Law, (4); Astronomy, (3).
Practicums.—Mechanical Drawing, (4); Machine Construction and Testing Strength of Materials, (6).

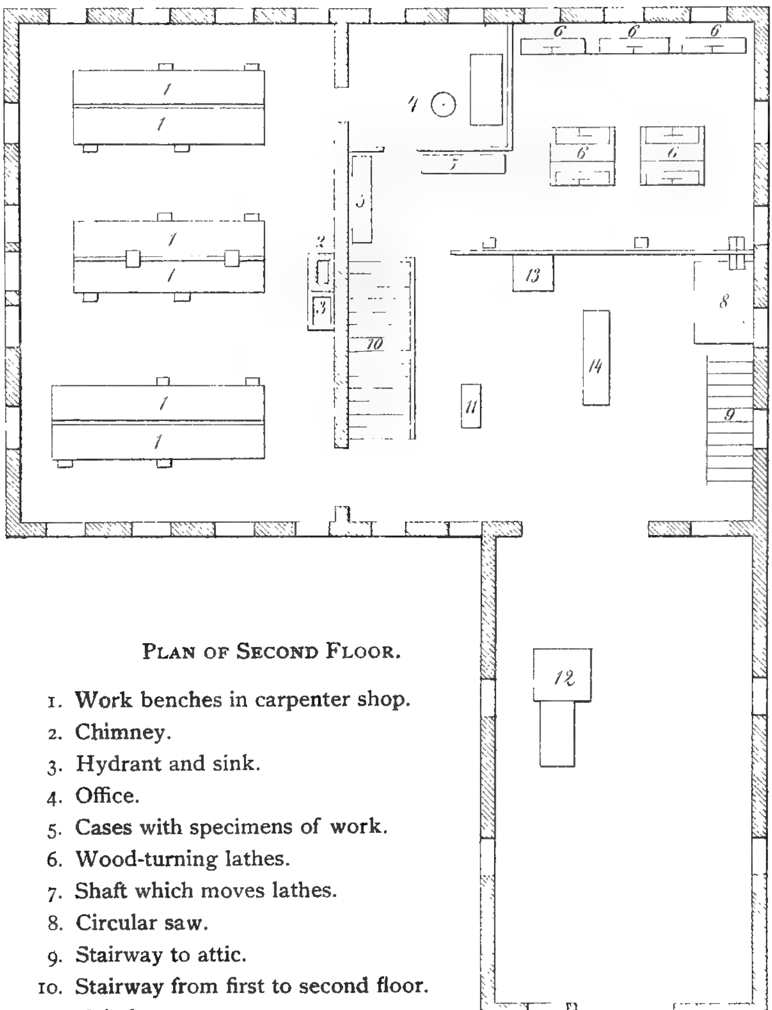
Spring Session.—Machine Design, (5); Electrical Machinery, (3); Hydraulic Motors, (3); International Law, (4).
Practicums.—Machine Construction, (4); Thesis Work, (6).

The following series of plates, showing the carefully arranged course of shop work in wood and iron working, is borrowed from the Annual Report of the Pennsylvania State College, as the best available illustration of a progressive series of exercises for a course in mechanic arts:



PLAN OF FIRST FLOOR.

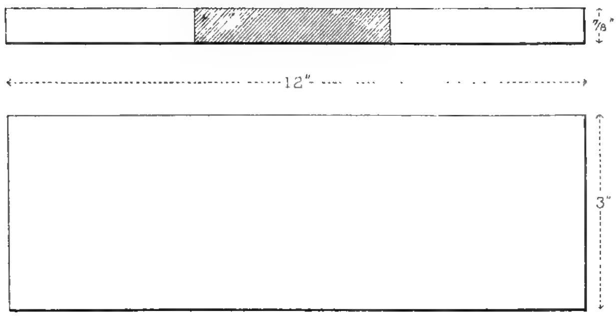
1. Shaping machine.
2. Iron-turning lathe.
3. Power grindstone.
4. Bench vises, for filing.
5. Hot water sink.
6. Tool room.
7. Closet.
8. Cold water sink.
9. Stairway to second floor.
10. Posts to which main shaft is attached.
11. Forges.
12. Stands for tools and work.
13. Anvils.
14. Large vises attached to post.
15. Iron room.
16. Steel pressure blower.
17. Closet.
18. Main shaft.
19. Coal tanks for forges.
20. Water tanks.
21. Chimney.
22. Box shear.
23. 16-inch P. & W. lathes, turret head.
24. 5-inch Sellers' planer.
25. Sellers' drill press.
26. Lumber room.



PLAN OF SECOND FLOOR.

1. Work benches in carpenter shop.
2. Chimney.
3. Hydrant and sink.
4. Office.
5. Cases with specimens of work.
6. Wood-turning lathes.
7. Shaft which moves lathes.
8. Circular saw.
9. Stairway to attic.
10. Stairway from first to second floor.
11. Grindstone.
12. Wood planer.
13. Scroll saw.
14. Universal woodworker.

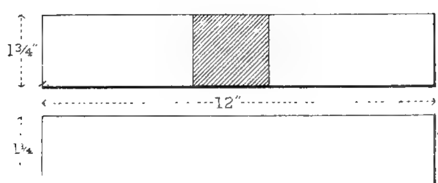
FIRST LESSON.



Planing.

The student is given a rough one-inch pine board from which he is to saw a piece 12 inches long and 4 inches wide. The difference between a ripping- and cross-cutting saw is here explained to him. He planes one side smooth, using the proper planes, and from this face the edges and other side are worked, making the edges at right angles and face parallel to the working face. No effort is made in this exercise to work to dimensions.

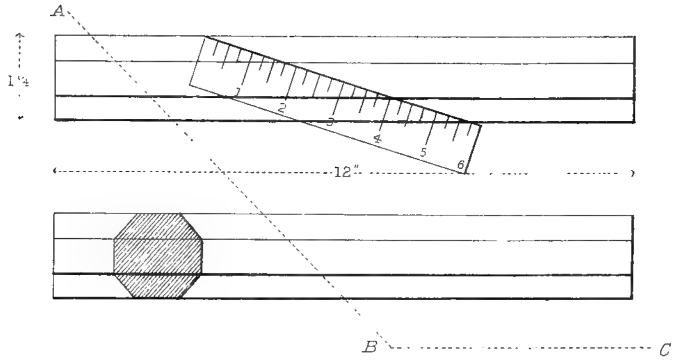
SECOND LESSON.



Planing Square Prism.

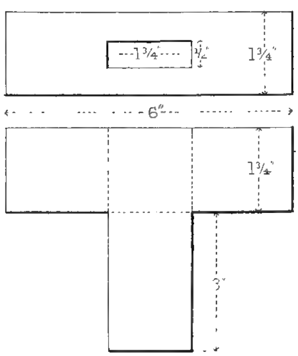
In this exercise, the material is 14 inches long and 2 inches square section. Two adjacent sides are first smoothed, care being taken to keep them at right angles to each other. With a gauge, it is then marked to 1¾ inches square and carefully worked to these lines. One end is then dressed with block plane and the piece sawed off and dressed to a length of exactly 12 inches.

THIRD LESSON.



The finished piece of the last exercise is now taken, and by method illustrated in accompanying cut, is marked so as to be planed to a regular octagon. The bevel is put at angle A B C=135°, so that the work can be tested as it proceeds.

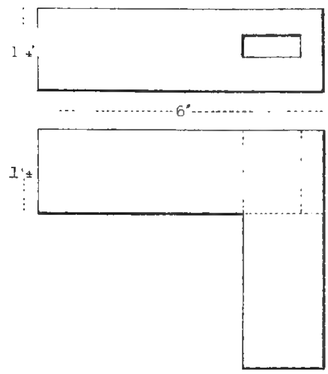
FOURTH LESSON.



THROUGH MORTISE AND TENON.

In this, as in the two following, the piece is gotten out 12 inches long and squared as in No. 2. It is then sawed in two pieces 5½ and 6½ inches in length. Mortise is laid off on 6½ inch piece and tenon on 5½ inch piece, marking being done with knife except when mortise gauge is used. The tenon is cut with the back saw, and the mortise bored and chiseled out. The ends are then cut to proper dimensions.

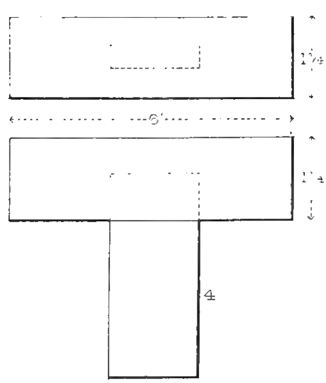
FIFTH LESSON.



POLISHED MORTISE AND TENON.

This piece is merely another form of No. 4, involving the same operations with a few modifications, as can be seen in the drawing.

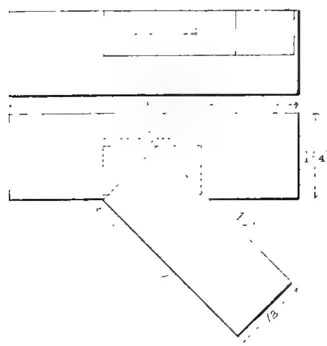
SIXTH LESSON.



DOUBLE MORTISE AND TENON.

The same as previous lessons, except there are two mortises and tenons instead of one.

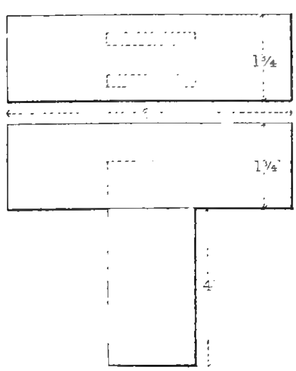
SEVENTH LESSON.



BRACE MORTISE AND TENON.

The brace is put at an angle of 45° and made of material 1½ x ⅞ inches. Tenon is flush with one side of brace and a shoulder cut on end. The whole brace is slightly dropped into mortise piece.

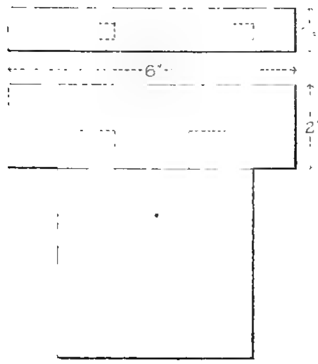
EIGHTH LESSON.



CONCEALED MORTISE AND TENON.

This differs from the preceding only that the mortise does not pass through the piece.

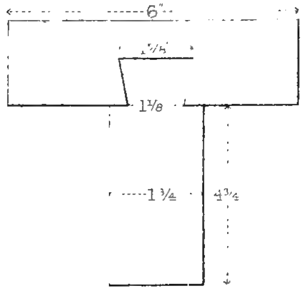
NINTH LESSON.



DOUBLE MORTISE AND TENON.

Another form of double mortise and tenon, made from inch material; differing slightly in detail and being somewhat more difficult to fit.

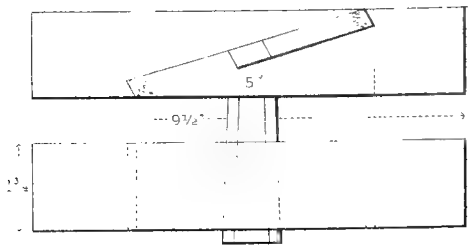
TENTH LESSON.



OPEN DOVE-TAIL JOINT.

The most elementary form of a dove-tail joint, affording exercise in laying off and cutting the mortise and tenons at oblique angles.

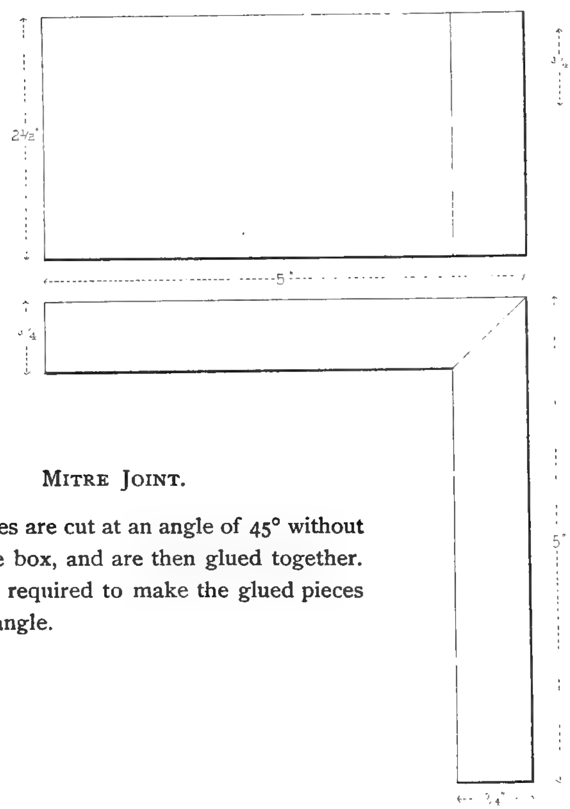
ELEVENTH LESSON.



KEYED SCARF JOINT.

This, on account of its oblique faces and splayed ends, is somewhat difficult to fit. The key forces the pieces into position and securely holds them there.

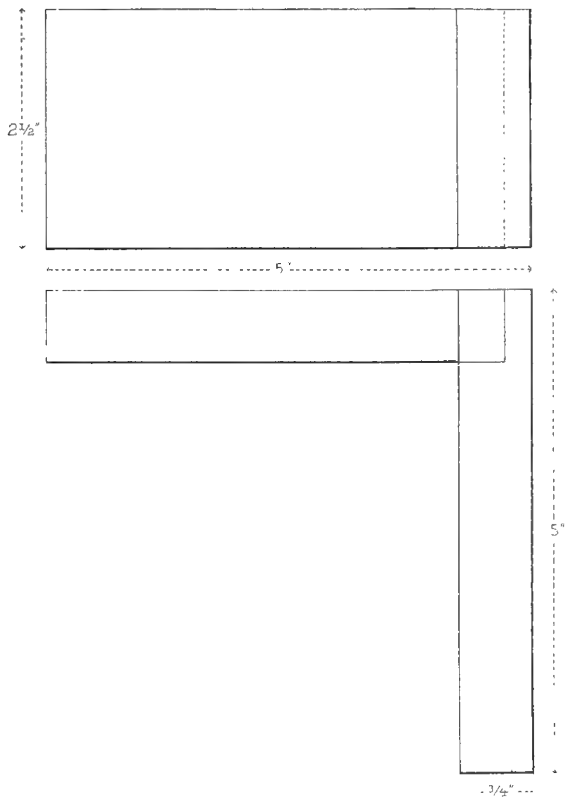
TWELFTH LESSON.



MITRE JOINT.

The mitres are cut at an angle of 45° without using a mitre box, and are then glued together. Great care is required to make the glued pieces form a right angle.

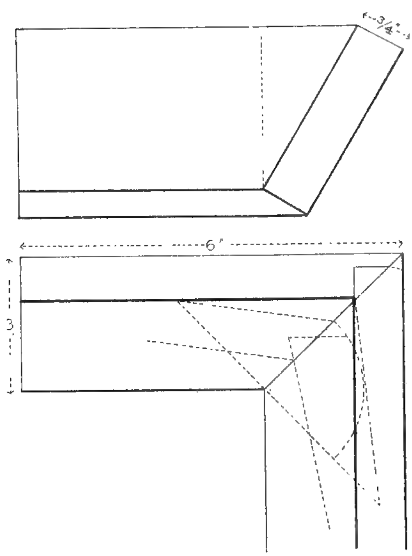
THIRTEENTH LESSON.



LAP JOINT.

In this, as in the preceding one, the difficulty is to make a neat fit at right angles.

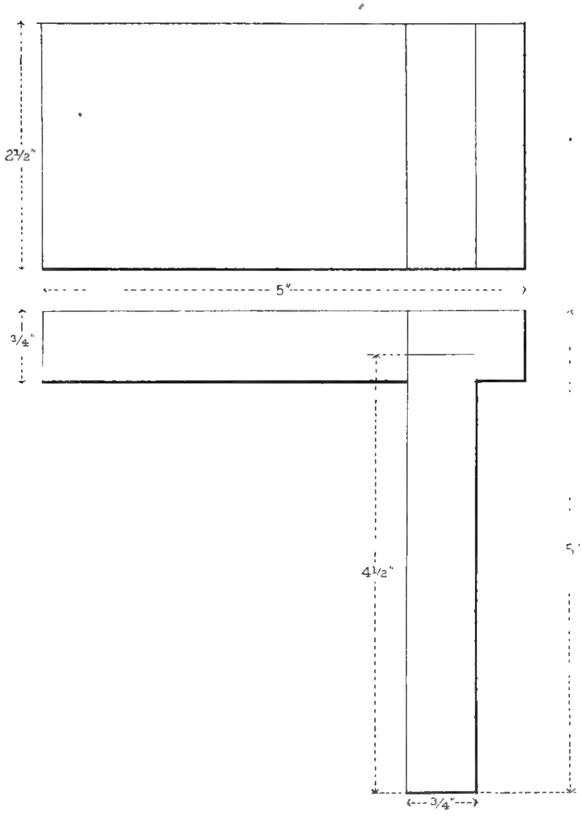
FOURTEENTH LESSON.



Hopper Lap Joint.

In the drawing but one angle of the hopper is shown, but the student makes the complete hopper. The method of laying off the work, which is somewhat complicated, is fully explained to him, and in no case is he permitted to proceed until it is laid out with precision.

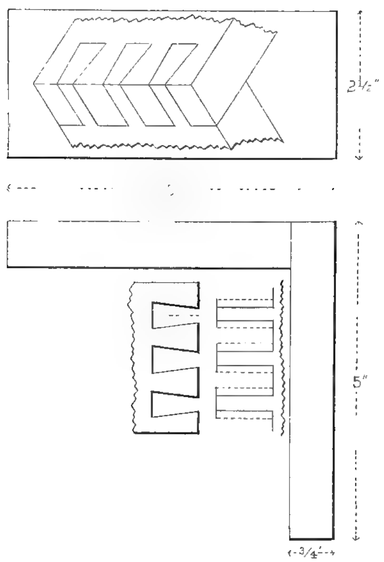
FIFTEENTH LESSON.



GAINED JOINT.

The inner surface of the gain must be flat and true, in order to produce the proper angle. The joint is glued.

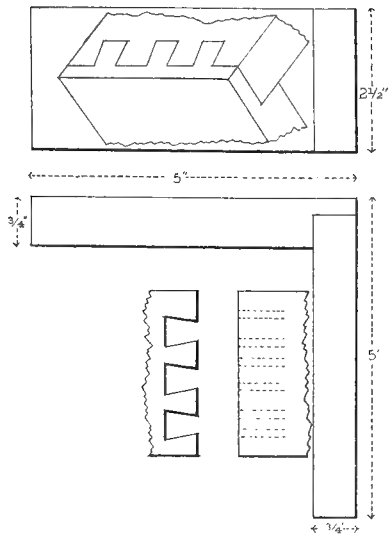
SIXTEENTH LESSON.



LAP DOVE-TAIL JOINT.

A more difficult form to lay off, cut and dress.

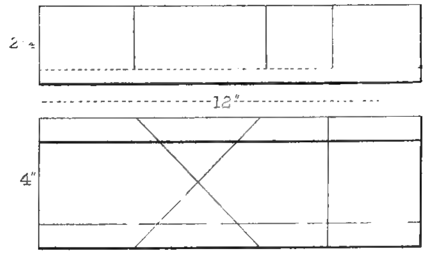
SEVENTEENTH LESSON.



THROUGH DOVE-TAIL JOINT.

The simplest form of a dove-tail joint at right angles, affording practice in laying off, cutting and dressing the corresponding parts to exact form and dimensions.

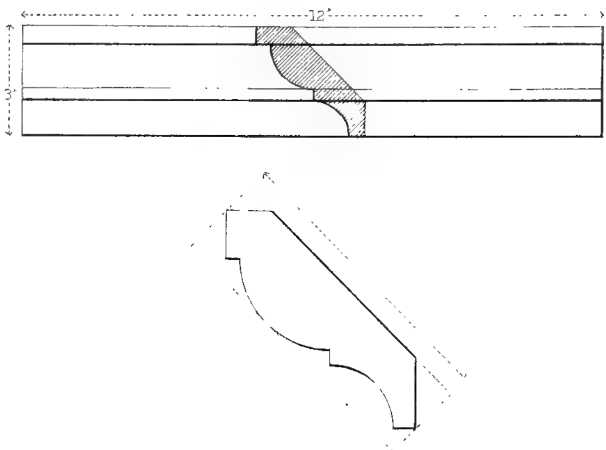
EIGHTEENTH LESSON.



MITRE BOX.

The box is for subsequent use in sawing mitres and must be made with great precision, angles, and right angles, and bottom of uniform width.

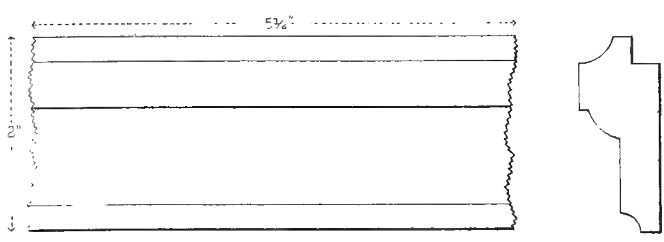
NINETEENTH LESSON.



MOULDING.

In this the work is laid off from an oblique section as indicated in drawing but of full size. The drawing of the oblique section is laid upon the material at the proper angle and pricked through, thus marking the lines at which the surfaces change direction. The proper tools are now taken and the material worked to the desired form. The hollow and rounding planes are used here for the first time.

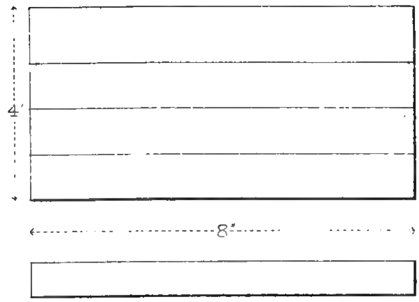
TWENTIETH LESSON.



ANOTHER FORM OF MOULDING.

Much as the former, except here a right section is taken from which to lay off the work, and the marking is done on the end of the piece.

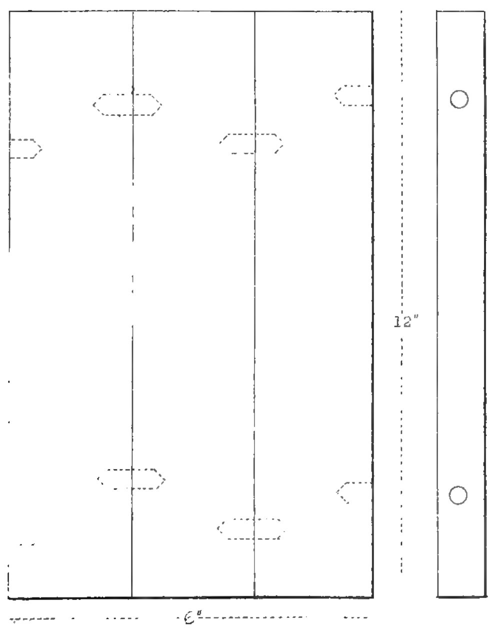
TWENTY-FIRST LESSON.



GLUE JOINTS.

This is made from alternate Cherry and Walnut strips so that the quality of the work can be seen at a glance.

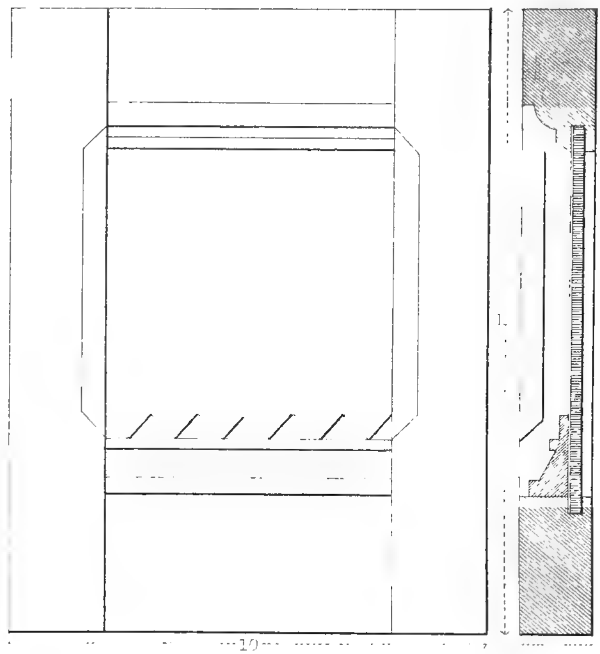
TWENTY-SECOND LESSON.



DOWEL JOINTS.

In this also two kinds of wood are used alternately. The drawing shows the nature of the work.

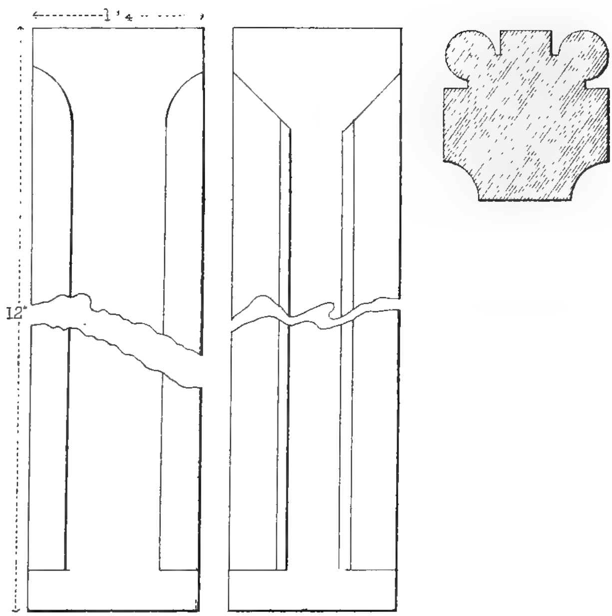
TWENTY-THIRD LESSON.



GOTHIC PANEL.

This exercise affords a variety of work. The inner edges of stiles are chamfered, the upper rail has moulding worked upon it, and the bottom of panel is veneered along the top of a piece of moulding placed above the lower rail. The panel and veneer are made of fancy woods, thus presenting a handsome appearance when completed.

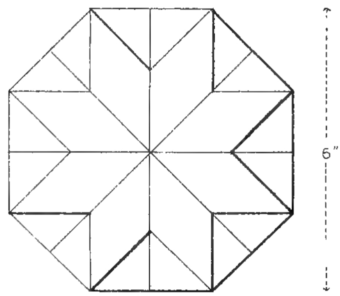
TWENTY-FOURTH LESSON.



WOOD CARVING.

The work is laid off with gauge, after the stick is dressed square. Templates are made from curves in full size sectional drawings. The cutting is done with chisels and carving tools, the templates being frequently applied in order to keep the moulding of proper shape and uniform size.

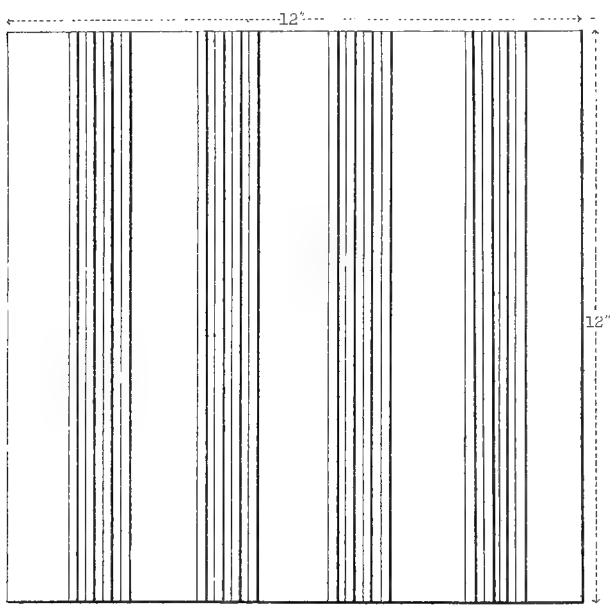
TWENTY-FIFTH LESSON.



ORNAMENTAL VENEERING.

The different pieces of veneer are made of different kinds of wood, thus producing a beautiful effect. It requires considerable care to bring the lines of divisions as indicated in the drawing.

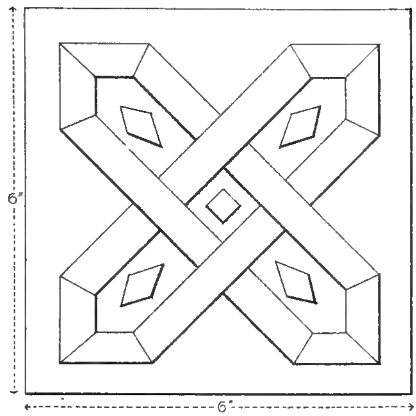
TWENTY-SIXTH LESSON.



ORNAMENTAL INLAYING.

Seven narrow strips of different kinds of veneer are glued together, so as to form a piece ¾ inch wide. That is then inlaid in a solid piece of hard wood, as shown in the drawing, a number of them being placed at regular distances apart.

TWENTY-SEVENTH LESSON.



MARQUETRY.

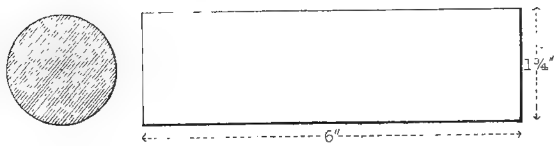
The narrow strips and diamond-shaped pieces are inlaid and made of different wood from the block into which they are put.

Machine Work in Wood.

The appliances for this work are as follows: Six wood-turning lathes, strained scroll saw, planer and circular sawing machine. With each lathe is a set of six turning chisels, a set of six gouges, a parting tool, a pair of calipers, a pair of compasses, a try-square, a two-foot rule and an oil can.

In this course not only the use of tools is necessary, but the eye must be carefully trained, as many of the varied forms which arise in wood-turning are tedious and difficult to measure. A skilled workman should, therefore, be able to produce work without measuring the smaller details that shall conform substantially to the drawing.

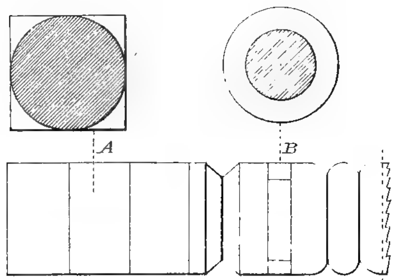
FIRST LESSON.



A CYLINDER.

A piece nine inches long and two inches square is taken. The corners are turned off and it is worked down to nearly the desired size with the gouge. The chisel is then used to work it to the given dimensions, which is determined by frequent application of the calipers.

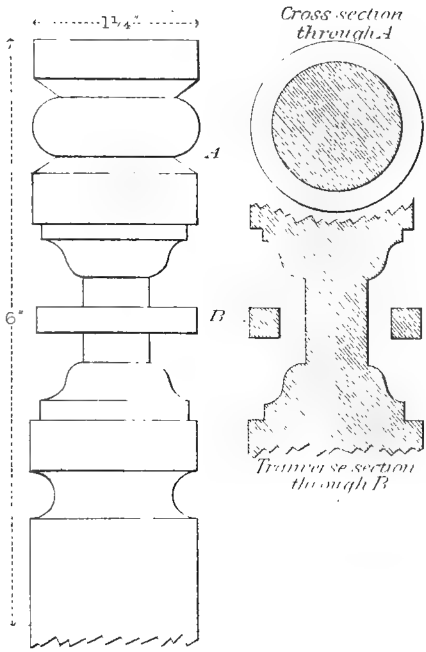
SECOND LESSON.



COMMON CUTS IN TURNING.

The drawing represents half the length, the remaining half being a repetition of what is shown. In this the cutting lines are marked and the depth is gauged by the use of calipers, but the forms of the curves in middle of the piece are determined entirely by the eye.

THIRD LESSON.

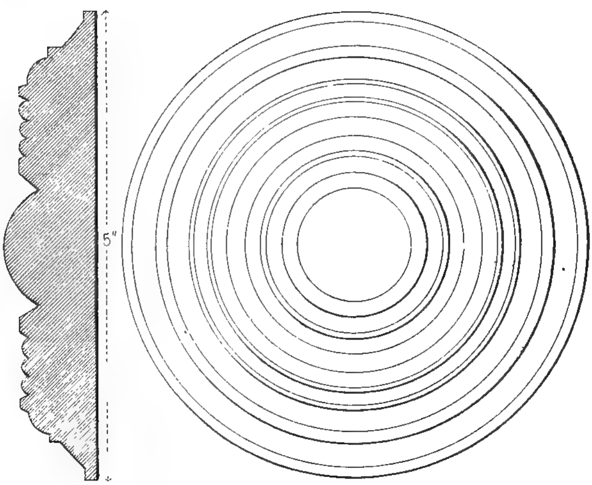


ORNAMENTAL TURNING.

In this we have a variety of curves, besides a loose ring to be turned upon the small cylinder, as shown in the transverse section in the drawing. The parts are all worked to given dimensions.

These pieces represent the elementary part of the work, and the student is kept upon these until he can produce them accurately and with rapidity.

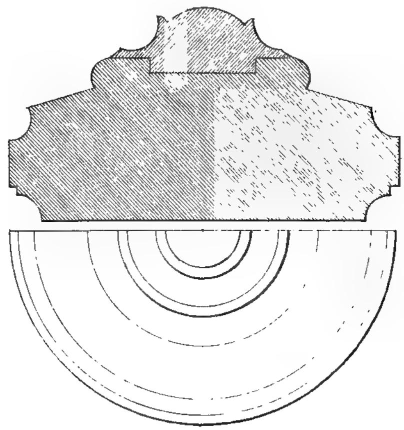
FOURTH LESSON.



FACE PLATE TURNING.

A piece six inches square is fastened upon the face plate from which the rosette, as indicated in the drawing, is to be turned.

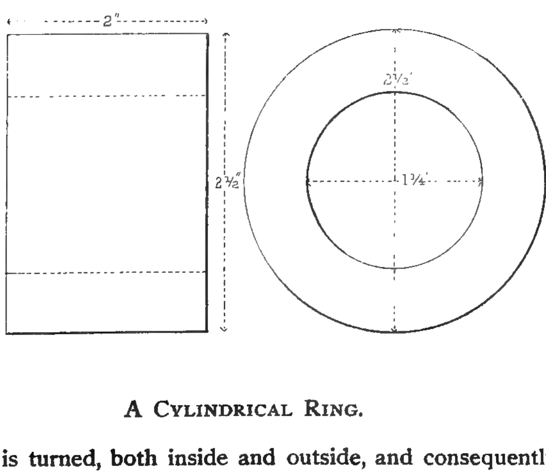
FIFTH LESSON.



NEWEL POST CAP.

The main part of the cap is made of Walnut. The central rosette, which is turned to fit into it, is of Cherry.

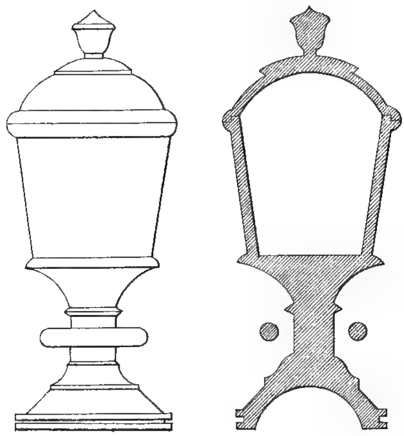
SIXTH LESSON.



A CYLINDRICAL RING.

This piece is turned, both inside and outside, and consequently requires two chuckings. It is made of either Cherry or Walnut.

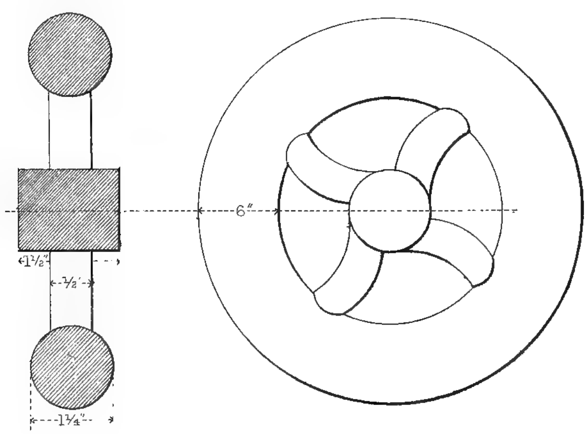
SEVENTH LESSON.



ORNAMENTAL VASE.

As can be seen in section, the vase is made with a lid which fits neatly upon it. The vase is turned both inside and outside as in case of the ring, but here the chucking is more difficult, and fitting the lid requires very careful work. There is a loose ring turned on the stem.

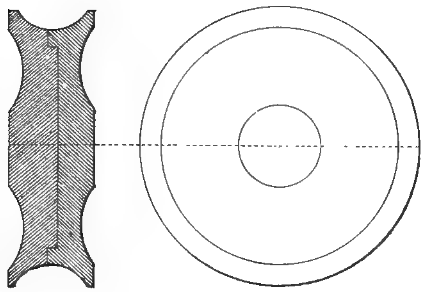
EIGHTH LESSON.



HAND WHEEL.

The rim and hub are turned. The spokes are cut out with saw and chisel.

NINTH LESSON.



GROOVED WHEEL.

It is made in two pieces, each of which is turned separately on an arbor. The inner part of one is turned the reverse of the other. When worked to nearly the given dimensions, they are both put upon the same arbor, driven tightly together, and finished in this position.

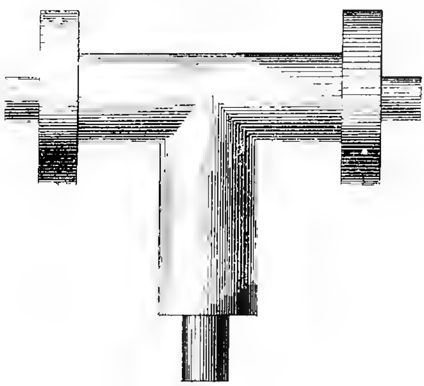
Pattern-Making.

The student is now ready for pattern-making, in which he will apply the knowledge and skill acquired in both carpentry and wood-turning.

As the applications for patterns extend into nearly every industry, a great variety of forms is required, and from these many courses of equal value might be arranged. In this course, with a few exceptions, we have, therefore, no fixed exercises for each class. After a few preliminary ones, the students are required to make patterns from drawings, previously made of some machine or part of a machine, which they are to construct later in their course.

The fact that the patterns are to be actually used is an incentive to good work. During the construction the student is shown how the grain should lie in the different pieces forming the pattern; where and what allowance is to be made for warping, shrinking, &c., and in what manner the different forms should be constructed to draw properly from the sand. The following plates are only preparatory to this course:

FIRST LESSON.

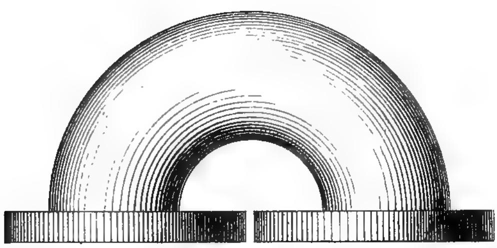


T PIPE.

The pattern is made in halves.

The body and flanges are first completed, the branch is then made and fitted to the body. Care must be taken that the branch is of such length that the fitting will bring to the size desired.

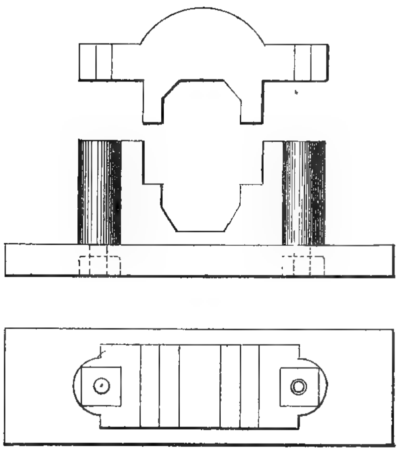
SECOND LESSON.



RETURN BEND.

A ring semicircular in section is first turned of such a radius as desired for the bend. As much of this is then taken as required for the pattern. The half flanges are fastened by screws passing through the center of the pattern into the flange.

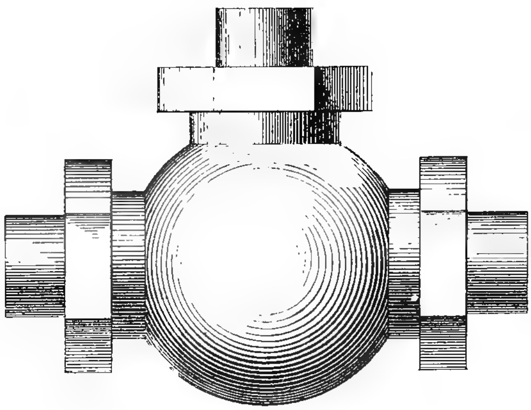
THIRD LESSON.



PILLOW BLOCK.

A piece is first prepared for the base of the desired size, allowing for the contraction of the casting in cooling. The pattern is built up from this as indicated in cut. The student is also required to make the core box.

FOURTH LESSON.



GLOBE VALVE.

In this the two pieces of wood are taken of sufficient size, so that when pegged together the ball or body of the pattern can be taken out of them. The branch is then made and fitted to the ball.

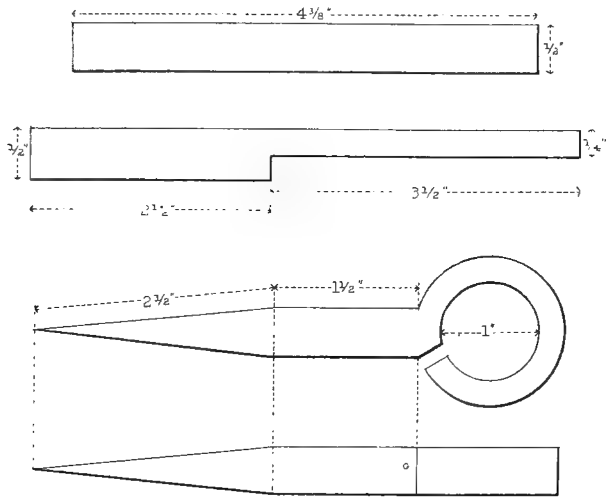
Forging.

For this work there are eight Sturtevant forges, each supplied with blast by a power blower, each provided with an anvil, tongs, punches, heading tools, hot and cold chisels, hammer and a two-foot square. There are also in this room four complete sets of swedging tools, set hammers, flatters, fullers, sledges, two large box vises, and a self-feed post drill. A drawing laid out to the working dimensions is placed in the forge room for reference during the exercise. The piece is then forged in detail by the instructor before the class, calling attention to the important points as he proceeds with the work. The student himself is then required to forge the piece, the instructor giving assistance only in case of necessity.

THE FIRST LESSON

Comprises the building and keeping of forge fires in proper condition upon which, in forging, so much depends. The student is also shown what degree of heat is necessary, and how to determine when that degree is obtained for the successful working of the various forms.

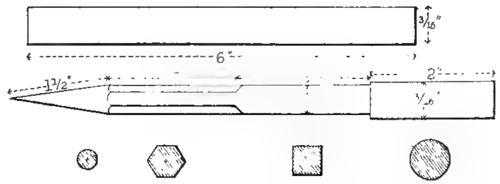
SECOND LESSON.



DRAWING, FORMING AND BENDING.

The successive steps of the exercise are fully explained by the drawing.

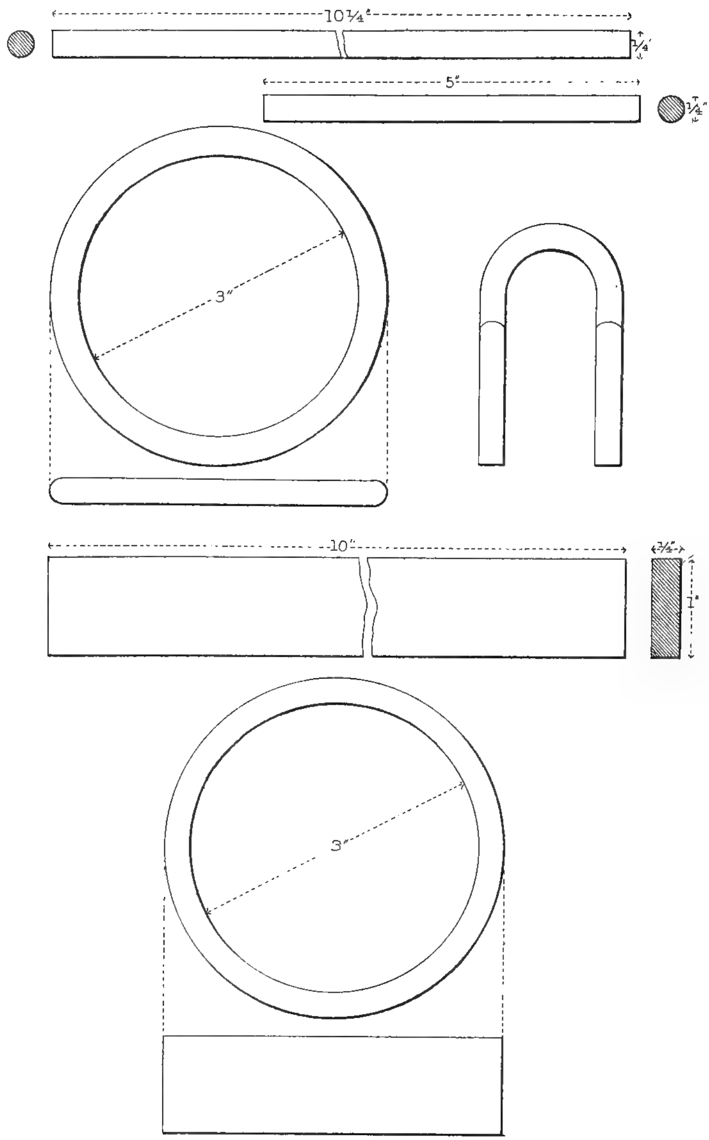
THIRD LESSON.



DRAWING AND FORMING.

As seen in the cross sections of the finished piece, a portion is round, another is square, another octagonal and the one end tapered to a round point. The student is here shown that a welding heat is necessary in drawing common iron, otherwise its parts are likely to separate lengthwise.

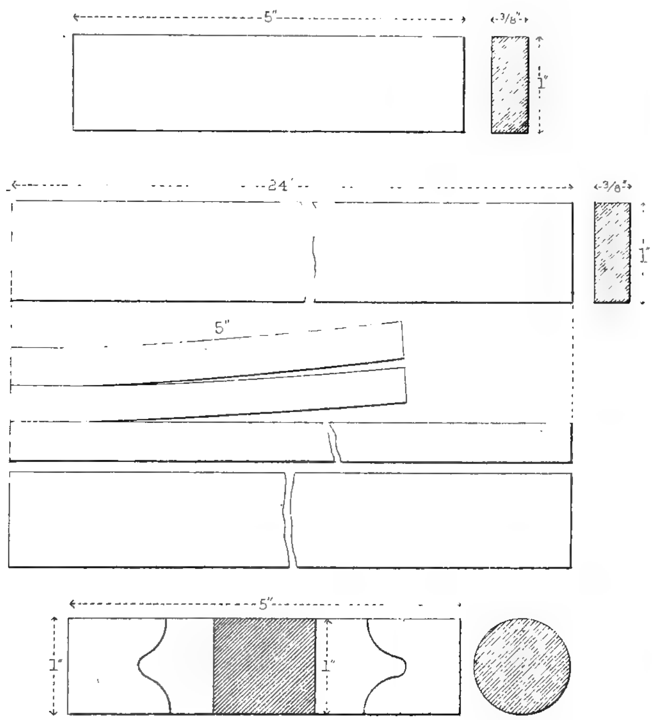
FOURTH LESSON.



BENDING.

One bar each of round and flat iron are bent in circular form and welded. In forming the staples, drawing as well as bending is involved. Whenever possible useful forms are invariably selected, but the introduction of principles is considered of the first importance, and frequently much time can be saved by taking plain forms.

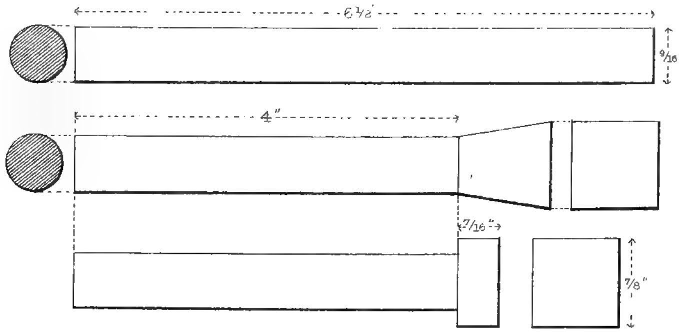
FIFTH LESSON.



FAGOT WELDING.

The one piece is two feet long for the purpose of holding it while welding upon it two four-inch pieces. In welding and rounding the ends, it is drawn out one inch. It is then cut off, and the ends dressed, making the finished piece five inches long.

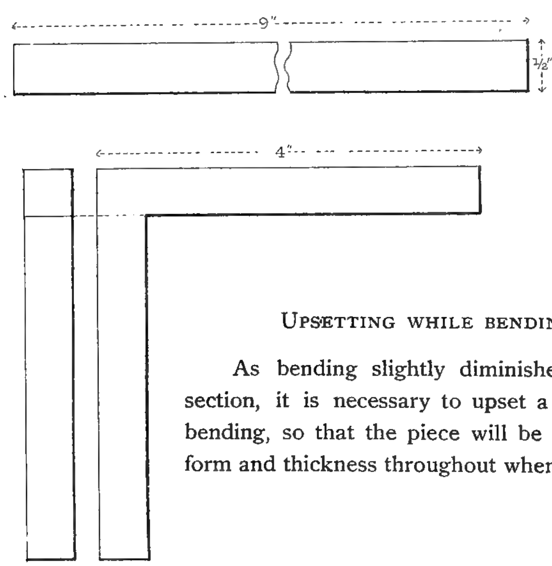
SIXTH LESSON.



UPSETTING AND BOLT-MAKING.

The material is six inches long. By upsetting it is diminished in length, while the part upset is increased in cross section, and squared in preparation for the head of the bolt of the finished piece.

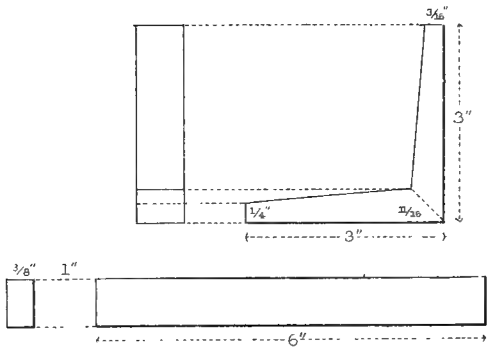
SEVENTH LESSON.



UPSETTING WHILE BENDING.

As bending slightly diminishes the cross section, it is necessary to upset a little, while bending, so that the piece will be of the same form and thickness throughout when finished.

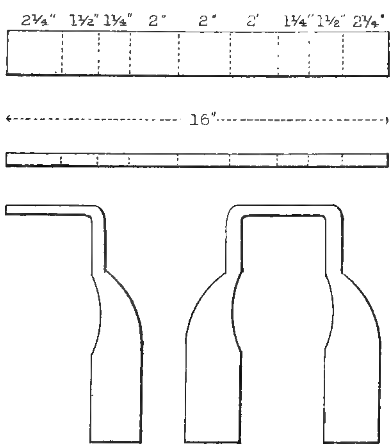
EIGHTH LESSON.



Upsetting Before Bending.

This piece is made heavy at the middle, and bent at that point. It makes a much stronger angle than the preceding one.

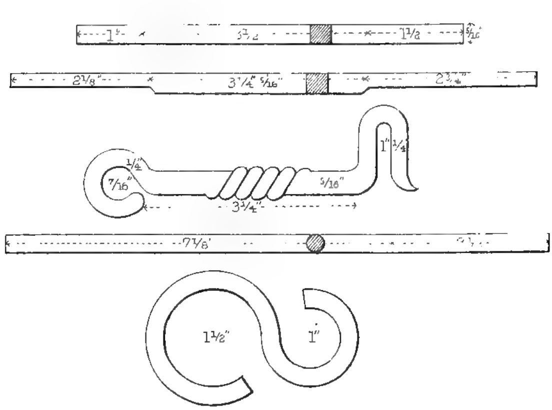
NINTH LESSON.



Bending and Twisting.

The bar is bent without upsetting. It is a post floor hanger, and is twisted to bring it to the proper shape to receive the timber.

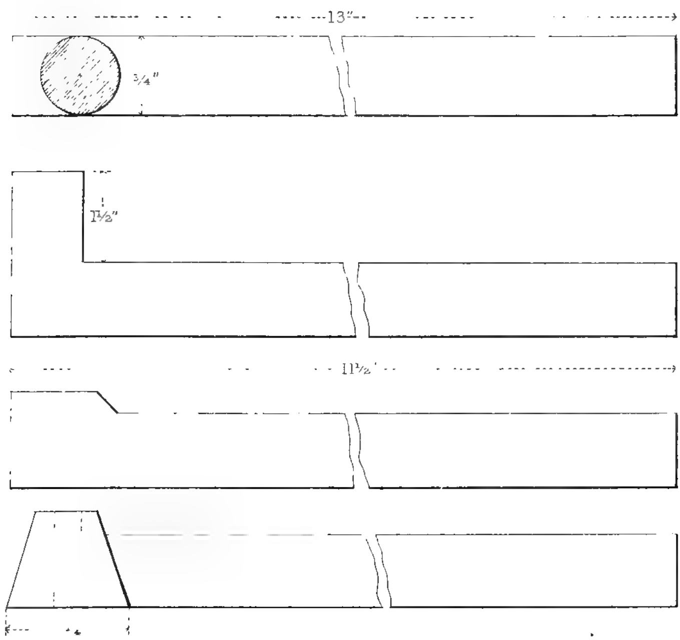
TENTH LESSON.



DRAWING, BENDING AND TWISTING.

The ends are drawn out for hook and eye and made round. The twist in central part is ornamental. The **S** hook is to accustom the student to forming graceful curves with iron.

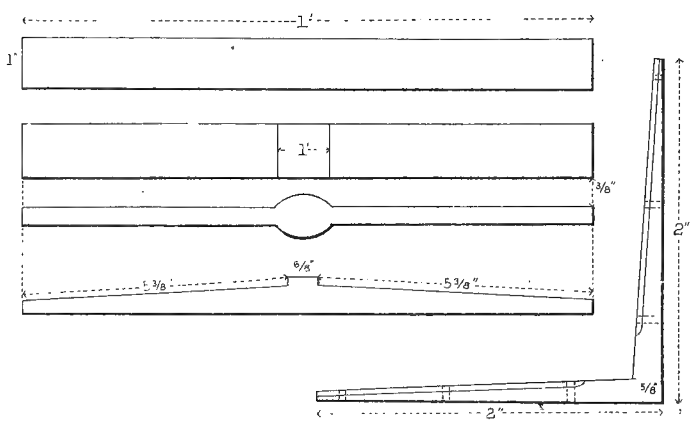
ELEVENTH LESSON.



UPSETTING, WELDING, FORMING AND PUNCHING.

A tool for making the heads of bolts, &c., called a heading-tool.

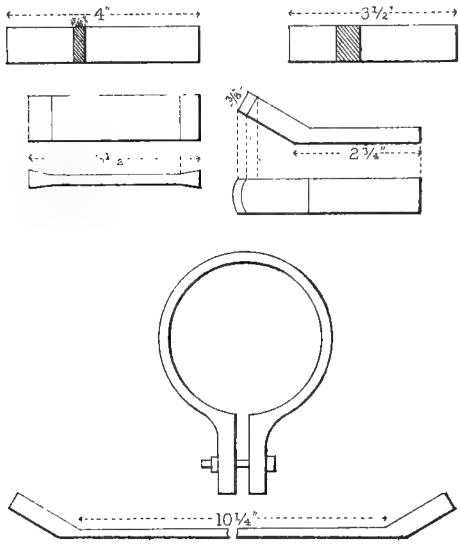
TWELFTH LESSON.



BRACKET.

This involves upsetting, drawing, bending, chamfering and punching.

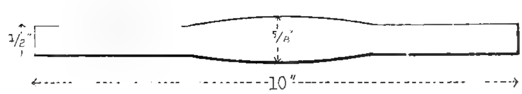
THIRTEENTH LESSON.



RING.

The ring is made from three pieces welded together. The main part being made of lighter material than the ends and angles.

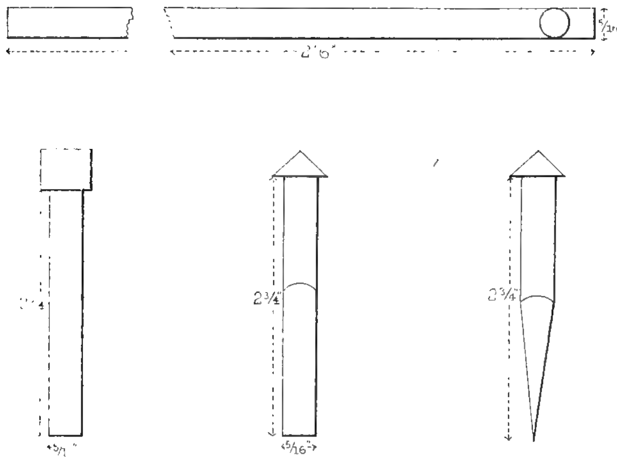
FOURTEENTH LESSON.



BUTT OR JUMP WELD.

The ends are upset and made square after which they are welded by butting them together Instruction is given as to how the weld should be dressed to preserve its strength.

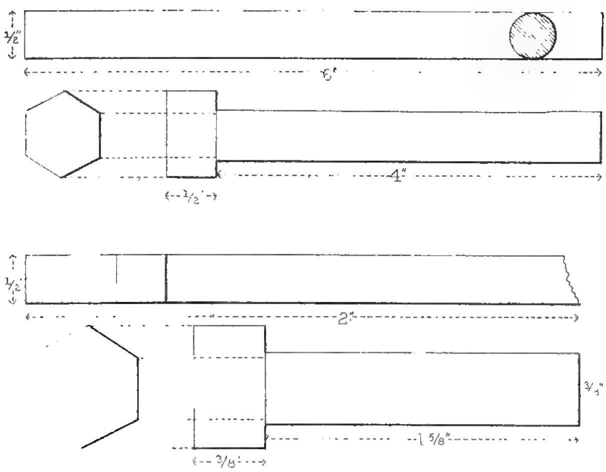
FIFTEENTH LESSON.



BOLTS AND RIVETS.

These are formed with the heading-tool made in lesson eleven. The principal feature in this exercise is to keep the stem in the centre of the head.

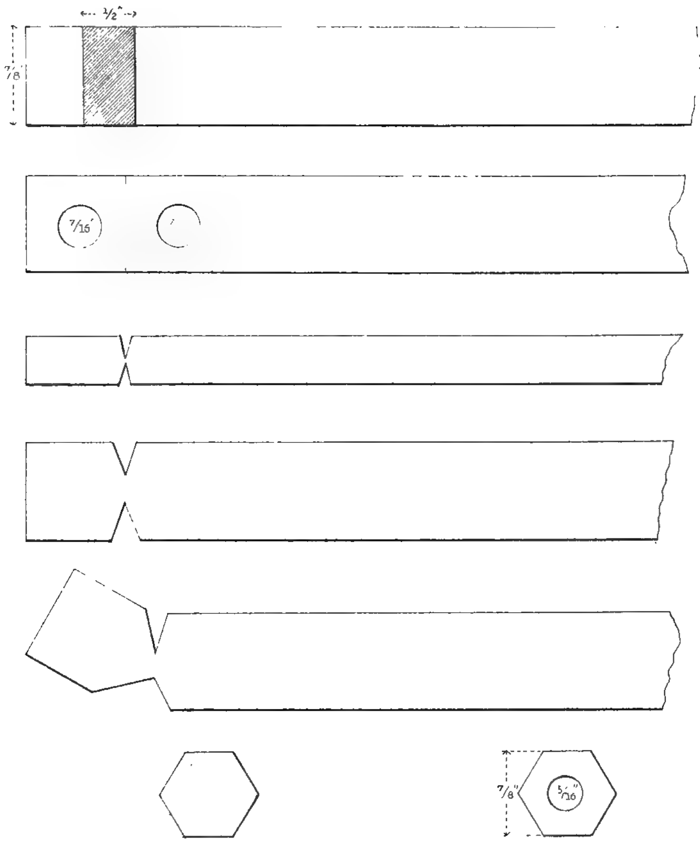
SIXTEENTH LESSON.



BOLT-MAKING.

The stock is upset as in a previous lesson, but in this the head is made hexagonal instead of square. Great care is necessary to make the head regular, and as in the lesson above, to keep the body of piece in centre of head.

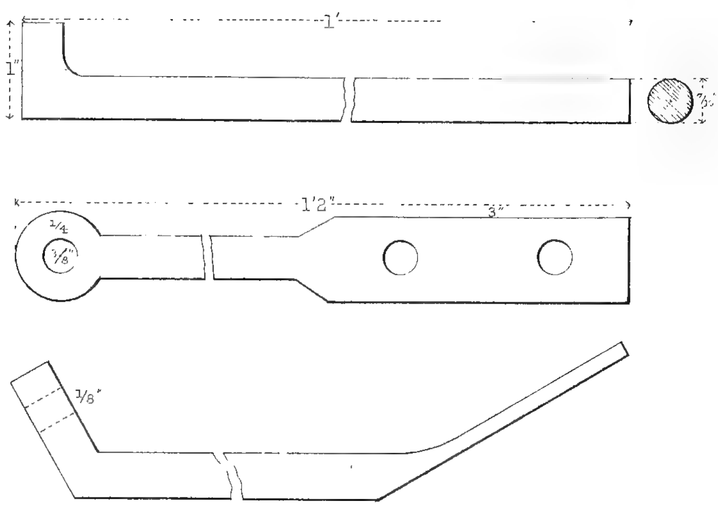
SEVENTEENTH LESSON.



NUTS.

The drawing explains the method of making hexagonal and square nuts.

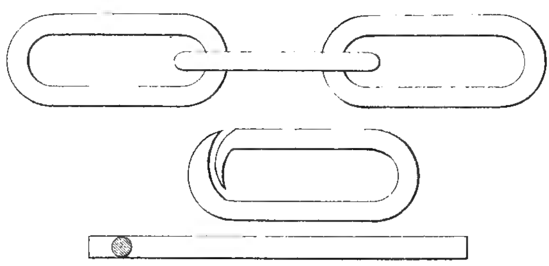
EIGHTEENTH LESSON.



EYE STAY OR BRACE.

The two ends are bent so as to be at right angles to each other while making different angles with the bar. The eye is formed from the body of the piece, while the tang is formed separately and welded on.

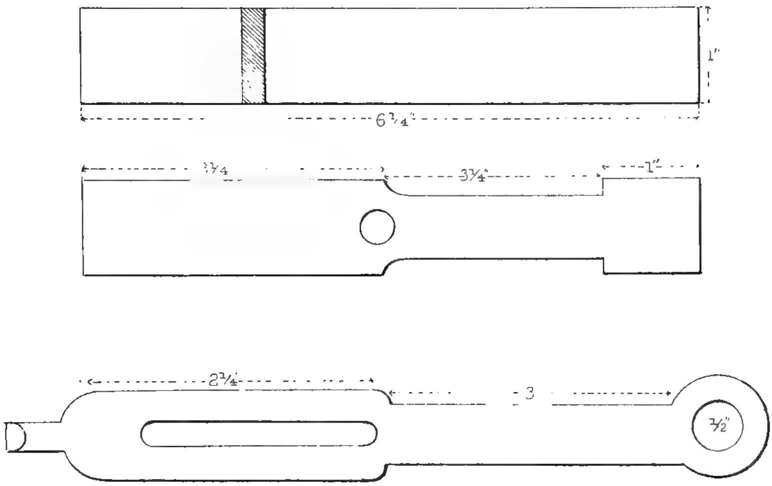
NINETEENTH LESSON.



WELDING LINKS.

In this the scarf is somewhat different from that in the ordinary weld. The links are twisted in the finished chain.

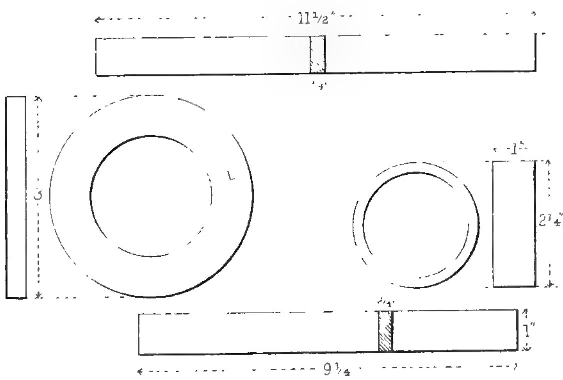
TWENTIETH LESSON.



HASP.

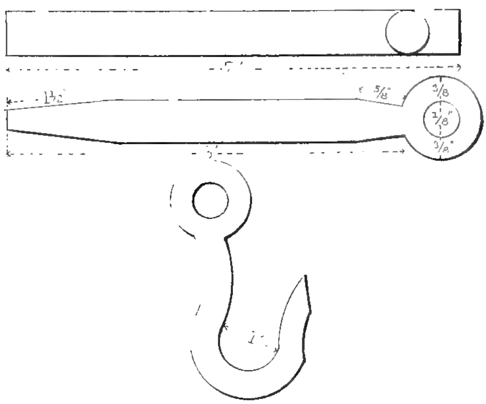
This brings in splitting, in connection with what has been given before.

TWENTY-FIRST LESSON.



Same as in a preceding lesson, except one piece is bent on its edge. The two are put together to show difference in the scarfing.

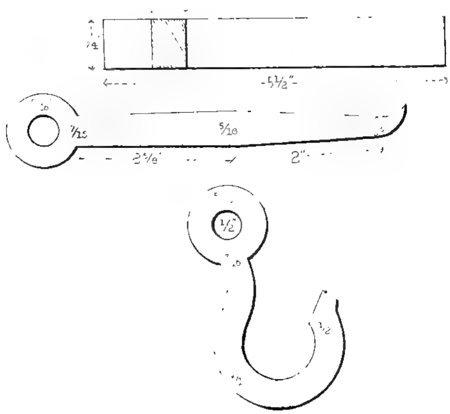
TWENTY-SECOND LESSON.



ROPE HOOK.

The eye is formed by turning and welding it in such a manner as to give it the appearance of being punched.

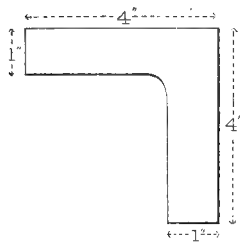
TWENTY-THIRD LESSON.



CHAIN HOOK.

In this the eye is punched and the greatest care is taken to give it the maximum strength with the material used.

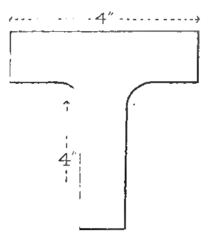
TWENTY-FOURTH LESSON.



WELDED CORNER.

Two pieces welded at right angles, illustrating the kind of scarf necessary for this weld.

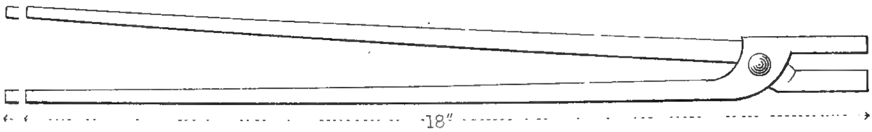
TWENTY-FIFTH LESSON.



T WELD.

In this the pieces are welded in the form of a **T**. The scarf is somewhat different and the weld is more difficult to make.

TWENTY-SIXTH LESSON.



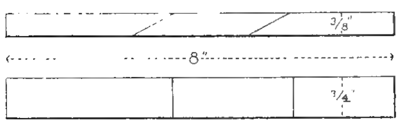
BLACKSMITH TONGS.

The jaws are made from ⅞ inch square iron and welded to lighter pieces for the handles. This exercise combines nearly all the principles that have been gone over in former lessons and closes the course in iron forging.

Steel Forging.

The student has now acquired considerable skill in producing forms, as well as regulating heat in the working of iron. In working steel slight variations are necessary, but he soon becomes familiar with these and is ready to take up hardening, tempering and annealing, which are of supreme importance in the making of tools, &c.

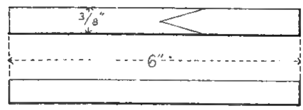
TWENTY-SEVENTH LESSON.



WELDING.

Steel to iron and steel to steel by lap weld.

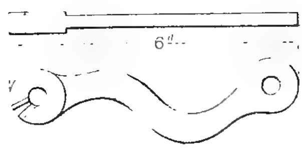
TWENTY-EIGHTH LESSON.



Iron and Steel Welding.

Steel welded to iron by split scarfing.

TWENTY-NINTH LESSON.



Wrench.

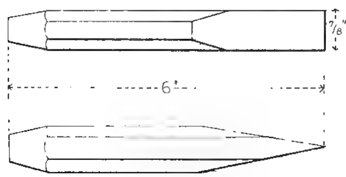
This is formed here to be finished in the filing course which follows. The student here finds the difference between working iron and steel.

THIRTIETH LESSON.

Blacksmith's Punch.

After forging it is hardened and tempered.

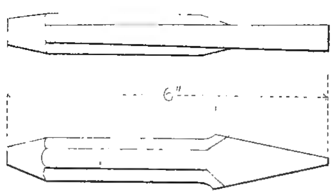
THIRTY-FIRST LESSON.



FLAT COLD CHISEL.

The forging is a sample form, but it gives practice in tempering.

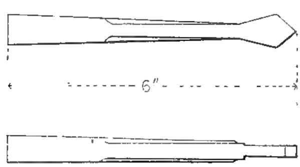
THIRTY-SECOND LESSON.



CAPE CHISEL.

Forming and tempering.

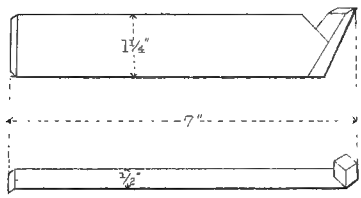
THIRTY-THIRD LESSON.



DRILL.

Here the form is somewhat more difficult to produce, and is tempered to a dark straw color instead of a brown, as in the two preceding lessons.

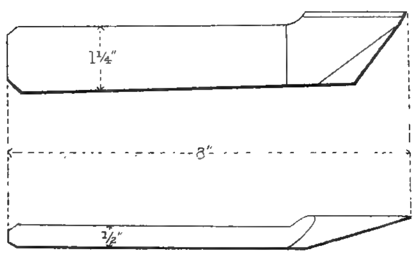
THIRTY-FOURTH LESSON.



LATHE TOOL.

Forged as indicated and properly tempered.

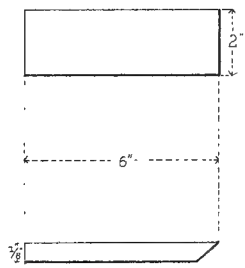
THIRTY-FIFTH LESSON.



SIDE TOOL.

These tools are comparatively easy to form after the course in iron forging, but close attention is necessary to properly temper them.

THIRTY-SIXTH LESSON.



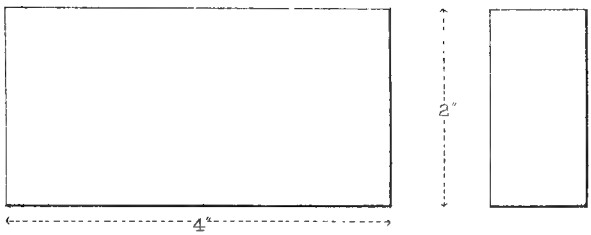
PLANE IRON.

In the preceding lessons on tempering the pieces have been hardened on or near the cutting edge, while in this the whole piece is tempered.

Vise Work.

For this work the shop is provided with eight swivel vises, and a supply of small tools, as follows: Cold chisels of different forms, chipping hammers, an assortment of files, file cards, try-squares, calipers, scratch gauges, hand vises, &c., &c. This course is intended to give practice in the use of different hand tools for metal, and also to teach the student how to keep them in order. Each lesson is varied in such a manner as to insure the introduction of the different shaped files. The castings are planed, not true, to remove the rough scales which are so injurious to files.

FIRST AND SECOND LESSONS.

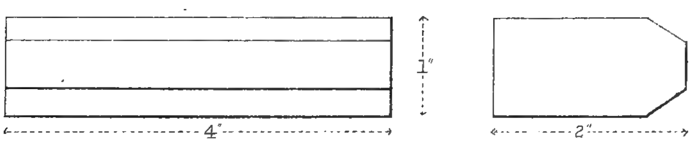


FILING TO LINE.

I. A plain block of cast iron is taken, and one face is filed true. The student is taught how to hold the file and move the arms to produce a true surface.

II. An edge and end are filed square with true surface, using a try-square to test the accuracy of the work.

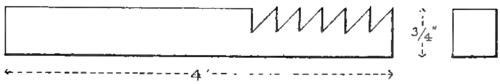
THIRD LESSON.



FILING HALF HEXAGON.

The same casting is used as in lessons one and two. The student lays out a half hexagon on the end of the piece, lines it, and then files it to the lines as indicated in the figure.

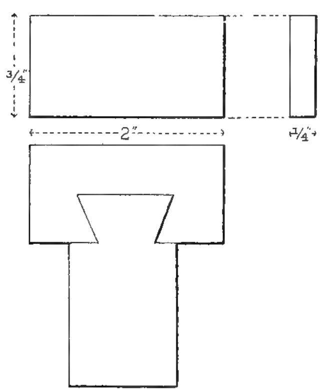
FOURTH LESSON.



RACK-TEETH.

This piece shows the different files used to form sharp angles of this kind.

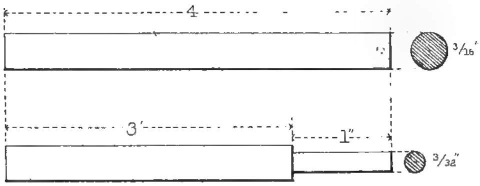
FIFTH LESSON.



DOVE-TAILING.

The piece being of wrought iron shows the difference of working the two metals. It introduces drilling, sawing and filing.

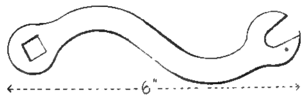
SIXTH LESSON.



SCREW BLANK.

This is reduced in size its entire length; then a portion is reduced more than the other forming a shoulder, the reduced portion being kept round in section and in the centre of the stock.

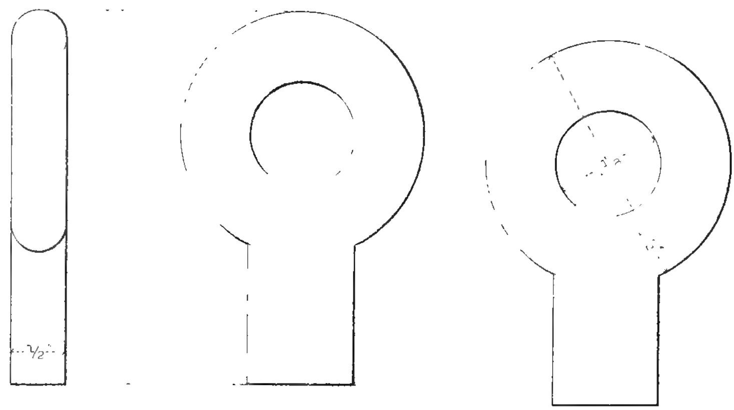
SEVENTH LESSON.



WRENCH.

The wrench made in the forging course. It introduces inside and outside curves, and a square hole to be filed from a round one.

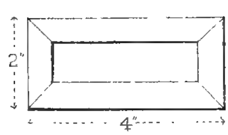
EIGHTH LESSON.



RING WORK.

The material for this exercise is on the right in the drawing and two projections of the finished piece are on the left. The object is to make the ring circular in section from the casting which is square in section, and to make all the surfaces of the tang straight and at right angles to each other.

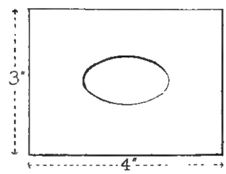
NINTH LESSON.



CHIPPING BEVEL.

The casting is lined by the student the proper distance from the edge which is to be beveled. It is cut down to the line, using a hammer and flat cold chisel.

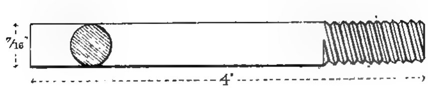
TENTH LESSON.



Oval Filing.

A flat piece of cast iron upon which an oval shape is marked out. It is drilled out as near to the marks as possible, and then chipped and filed to the line.

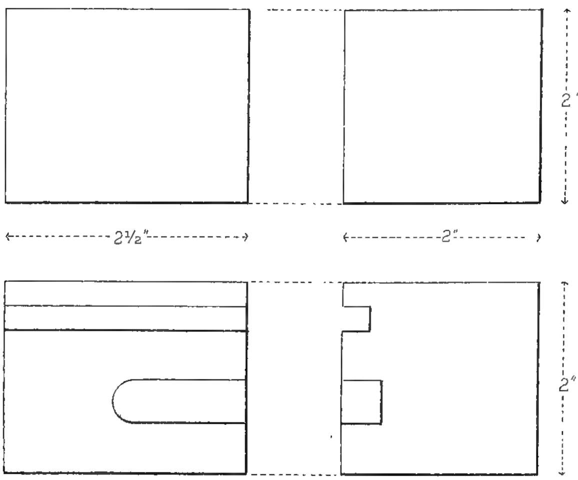
ELEVENTH LESSON.



Thread Cutting.

A line representing the thread is marked off twelve times around the piece, the pitch being kept the same throughout. The filing is done by using the half-round and three-cornered files.

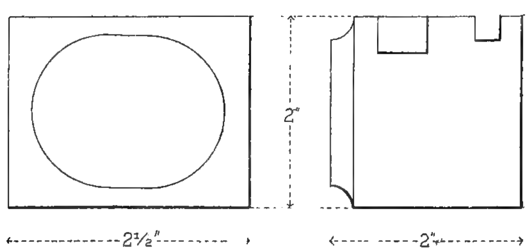
TWELFTH LESSON.



CHIPPING (WROUGHT IRON.)

A rectangular groove ¼ x ¼ inch is chipped entirely across the face of the piece, and another groove ½ x ⅜ inch three-eighths of the distance across.

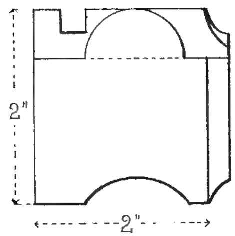
THIRTEENTH LESSON.



CHIPPING.

Same block is used. An oval is cut upon one side introducing concave chipping, as is shown in the right-hand projection.

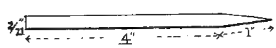
FOURTEENTH LESSON.



CONVEX CHIPPING.

Here, on same block, is introduced convex chipping in the form of a half cylinder part way across the face of the piece. Also, more concave cutting.

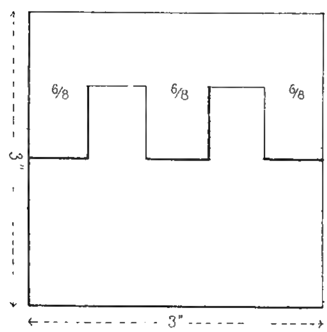
FIFTEENTH LESSON.



HAND VISE FILING.

A round piece of steel is reduced in diameter its entire length and filed at one end to a tapering joint.

SIXTEENTH LESSON.



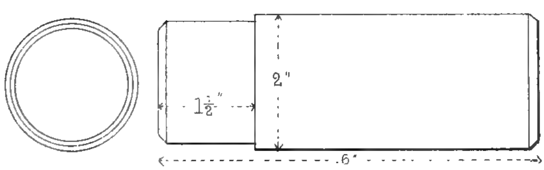
PARALLEL FITTING.

The casting is lined by the student and fitted as shown in the plate. The practice which he has acquired is here called into use as one misstroke of the file may necessitate his beginning a new piece.

Machine Work in Iron.

In this course, after a few elementary pieces, the student is required to build some machine. If it is too large for one to complete during his course, more students are put upon it, and in this way a working piece of mechanism is produced, the result of their combined efforts. We hope, by this method, to add to our equipment special machines designed and built by our own students in mechanical engineering. Some little work has already been done by special students. Below will be found a few of the elementary lessons required by all students who enter upon this work.

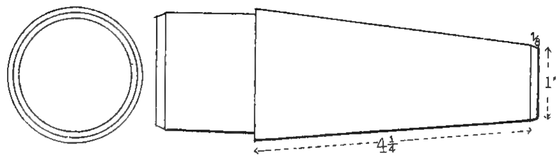
SECOND LESSON.



Plain Turning.

The piece is centred, put upon the lathe and ends faced up, making it exactly six inches in length. It is then turned down its entire length to two inches in diameter. A portion of it is then cut down to a smaller diameter, leaving a square shoulder one and one-half inches from the end. The ends are then chamfered. The exercise gives practice in selecting, grinding and setting the proper cutting tools.

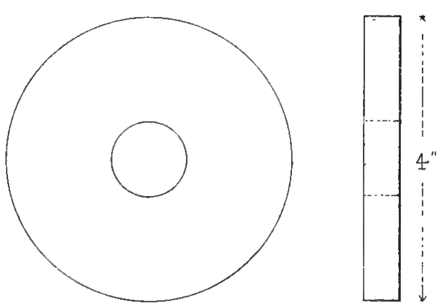
THIRD LESSON.



TAPER TURNING.

The finished piece of last exercise is taken for the stock of this. The object of this lesson is to show how, by moving the toil stock to the front or rear, any desired taper may be turned.

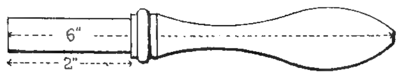
FOURTH LESSON.



CHUCKING AND BORING.

The solid blank is centred, and then bored out by placing the drill in the slot of tool posts and using toil stock to force drill through.

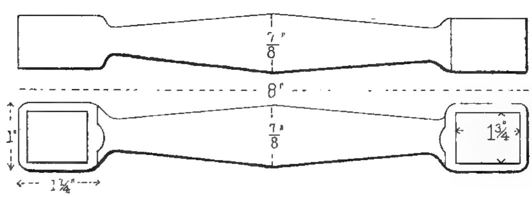
FIFTH LESSON.



A HANDLE.

This lesson gives practice in using the cross feed by hand to produce a given curve, while the longitudinal feed is operated by the lathe.

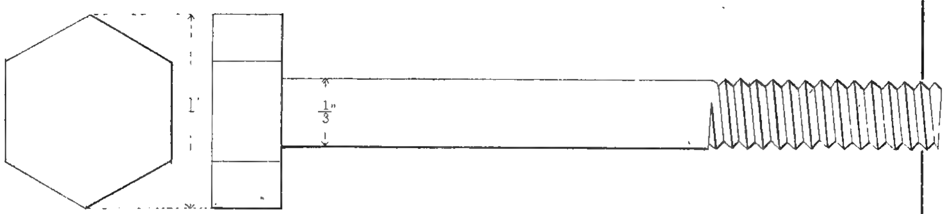
SIXTH LESSON.



CONNECTING ROD.

This involves about all the principles of the preceding lessons besides some planer work.

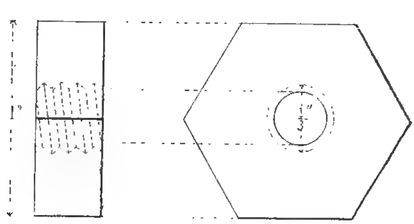
SEVENTH LESSON.



SCREW CUTTING.

The student is shown how to arrange the gearing for cutting threads of different pitch. He then cuts twelve threads to the inch upon the bolt given him.

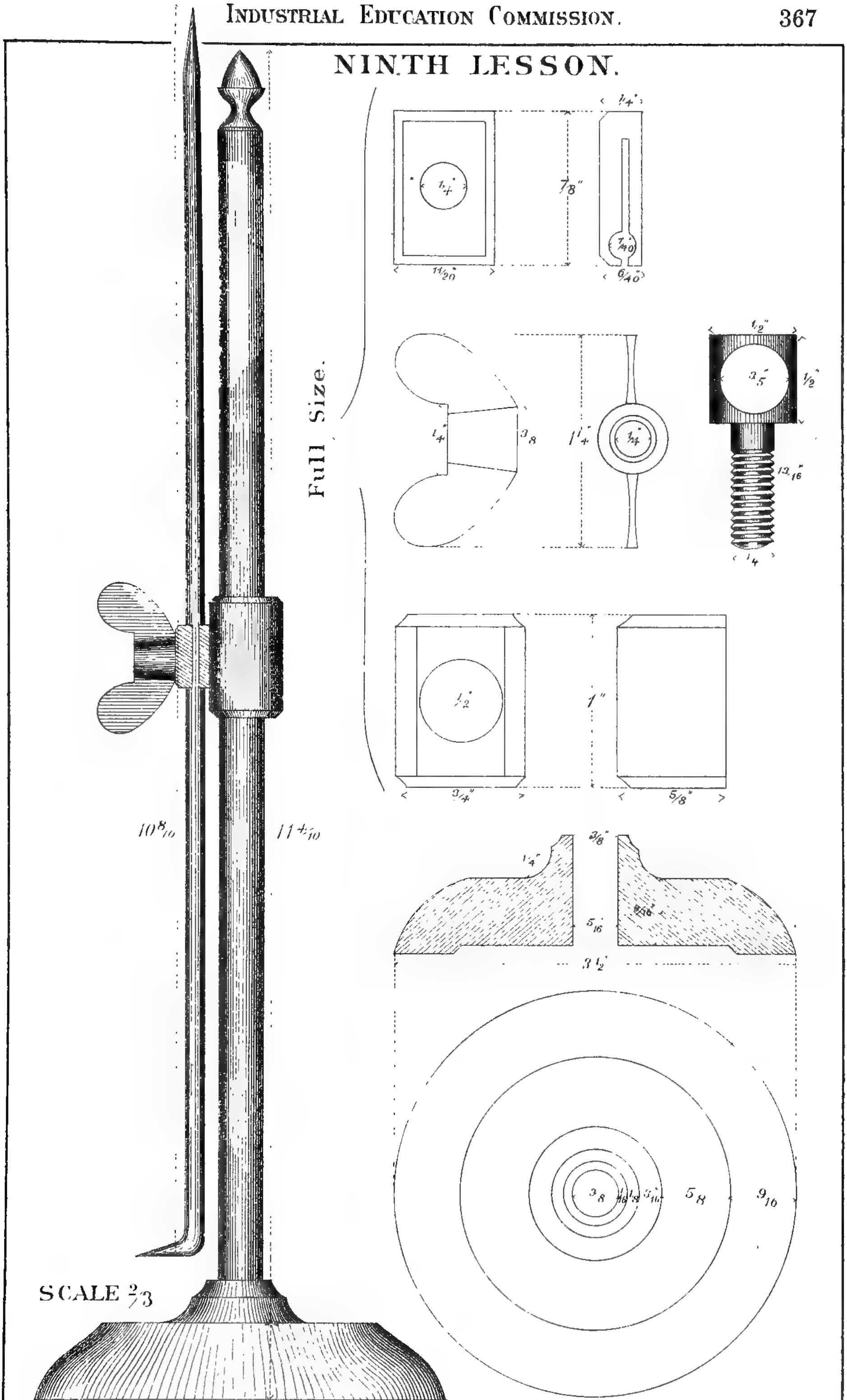
EIGHTH LESSON.



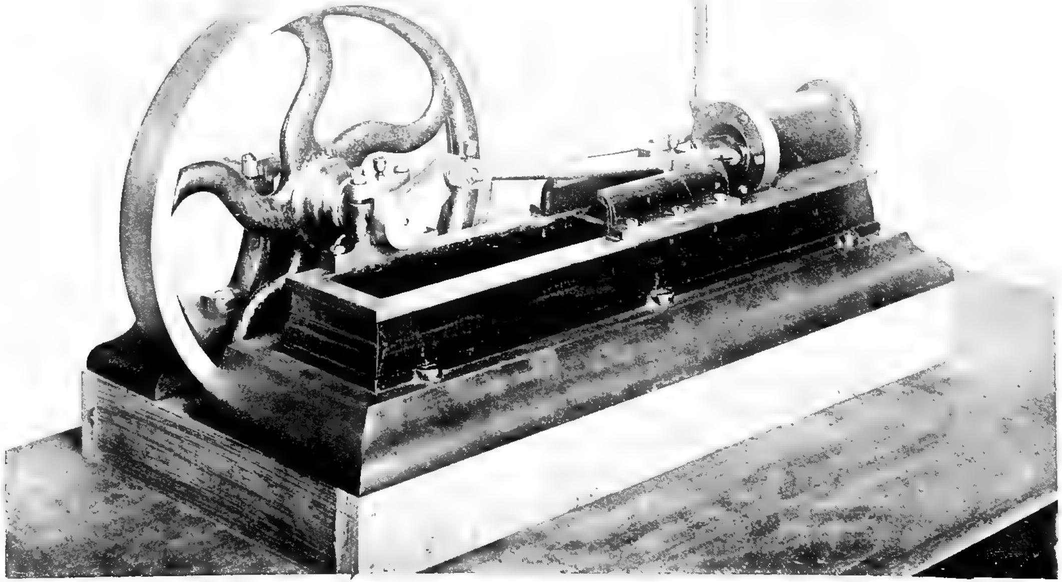
INSIDE SCREW CUTTING.

The thread is cut for the bolt in the preceding lesson.

NINTH LESSON.



FACE GAUGE.



HORIZONTAL ENGINE.

Working Model made entirely by Students of the Pennsylvania State College.

8. Swarthmore College.

Swarthmore College offers four courses of study. 1. Course in arts, 2. Course in letters, 3. Course in science, 4. Course in engineering.

Candidates for admission to the freshman class are examined in the following subject: *Mathematics:*—Arithmetic, algebra, through equations of the second degree of one unknown quantity, geometry. The whole of plane geometry: *English:*—History, geography.

In addition to the above, the candidate will be examined in one of the following subjects as he may elect:

5. *Latin.*—Cæsar, Gallic War, four books; Virgil's Æneid, six books; Allen's Latin Composition; as much knowledge of Roman antiquities as may be gained from Wilkin's Primer; as much knowledge of classical geography as man be gained from Tozer's Primer; and as much knowledge of classical mythology as may be gained from Cox's Manual of Mythology.

For the Cæsar other Latin may in certain cases be substituted, but only in accordance with previous agreement.

6. *French.*—The candidate should be familiar with the grammar, especially with the formation and use of verbs. He should be able to read easy French at sight, and to translate simple English sentences into French.

7. *German.*—The preparation in German should occupy one year. The candidate should be able to read easy German at sight, and to translate simple English sentences into correct German.

Candidates for the classical section must pass the above examination in Latin.

Greek is not required for admission, but students who have been prepared in Greek may continue in that language with students in the higher college classes.

Candidates for the scientific section, who have had no opportunity to prepare in Latin, French or German, will not be rejected on account of such deficiency, if they are otherwise qualified. An opportunity will be offered to make up the deficiency after admission.

For Advanced Standing—Candidates must be further examined in the studies already pursued by the class for which they present themselves; but in the case of such students, real equivalents are accepted for any of the studies gone over by the class.

Candidate for the freshman class are admitted on certificate without examination from certain approved schools.

The cost of board and tuition is $450 per year.

A deduction of $100 per year is made to all students who are children of members of the religious society of friends.

For day scholars the price is $200 per year.

The course in engineering, leading to the degree of bachelor of science in engineering offers, in its various studies and exercises, a

training which is believed to be well adapted to the needs of civil and of mechanical engineers, as well as of the large class who are to be concerned with the material interest of the country, with manufacturing, with industrial pursuits, or with any of the many other occupations allied to engineering. It embraces liberal and technical instruction in the mathematical, physical and graphical sciences, and their applications, in practical field engineering, in the arts of design and construction, and in the use of tools, materials, and machinery, and in processes.

STUDIES OF THE COURSE IN ENGINEERING.

Elective studies must be so chosen as not to interfere with those which are prescribed.

FRESHMAN YEAR.

FIRST SEMESTER.—*Prescribed.*—Shop Work and Draughting, 6; Mathematics, 4; Chemistry, 4; Natural History, 2; Electives, 4. Total, 20 Periods.

Electives.—French, 4; History, 4; English, 4.

Extras.—Phonography, 2; Drawing and Painting, 2; Pedagogics, 2; Elocution, 2.

SECOND SEMESTER.—*Prescribed.*—Shop Work and Draughting, 6; Mathematics, 4; Chemistry, 4; Rhetoric, 2; Electives, 4. Total, 20 Periods.

Electives.—German, 4; English, 4.

Extras.—Phonography, 2; Drawing and Painting, 2; Pedagogics, 2; Elocution, 2.

SOPHMORE YEAR.

FIRST SEMESTER.—*Pre cribed.*—Descriptive Geometery and Surveying, 4; Shop Work and Draughting, 4; Mathematics, 4, Chemistry, 2; Physics, 2; Electives, 4. Total, 20 Periods.

Electives.—German, 4; English, 4.

Extras.—Phonography, 2; Drawing and Painting, 2; Pedagogics, 2; Elocution, 2.

SECOND SEMESTER.—*Prescribed.*—Mechanics, 4; Shop Work and Draughting, 4; Mathematics, 4; Chemistry, 2; Physics, 2; Electives, 4. Total, 20 Periods.

Electives.—French, 4; History, 4; English, 4; Elocution, 2; Descriptive Astronomy, 2.

Extras.—Phonography, 2; Drawing and Painting, 2; Pedagogics, 2.

JUNIOR YEAR.

FIRST SEMESTER.—*Prescribed.*—Engineering, 6; Engineering Practice, 2; Mathematics, 4; Physics, 4; Electives, 4. Total, 20 Periods.

Electives.—Chemistry, 4; Biology, 4; German, 4; History, 4; English 4.

Extras.—Phonography, 2; Drawing and Painting, 2; Pedagogics, 2; Elocution, 2.

SECOND SEMESTER.—*Prescribed.*—Engineering, 6; Engineering Practice, 2; Mathematics, 4; Physics, 4; Electives, 4. Total, 20 Periods.

Electives.—Chemistry, 4; Biology, 4; French, 4; History, 4; English, 4.

Extras.—Phonography, 2; Drawing and Painting, 2; Pedagogics, 2; Elocution, 2.

SENIOR YEAR.

FIRST SEMESTER.—*Prescribed.*—Engineering, 8; Engineering Practice, 4; Elocution, 2; Logic, 1; Geology, 1: Electives, 4. Total, 20 Periods.

Electives.—Astronomy, 4; Political Science, 4; English, 4; French, 4; Chemistry, 4; Biology, 4; Mental and Moral Philosophy, 4; Physics, 4; Mineralogy, 2; Pedagogics, 2.

Extras.—Phonography, 2; Drawing and Painting, 2,

SECOND SEMESTER.—*Prescribed.*—Engineering, 8; Engineering Practice, 4; Elocution, 2; Logic, 1; Geology, 1; Electives, 4. Total, 20 Periods.

Electives.—Astronomy, 4; Political Science, 4; English, 4; German, 4; Chemistry, 4; Biology, 4; Mental and Moral Philosophy, 4; Physics, 4; Mineralogy, 2; Pedagogics, 2.

Extras.—Phonography, 2; Drawing and painting, 2.
Physical culture is required of all.
Essays are required throughout the course.

The department of engineering is intended to give a good preparation to those students who are expecting to become either civil or mechanical engineers. The studies and exercises are so arranged that the graduates will be prepared to become immediately useful in the office, works, or field, in subordinate positions, and, after a fair amount of such practice, to design and take charge of important works.

The location of the college near Philadelphia and the many important manufacturing cities in its vicinity, permits frequent visits to industrial and engineering works of every kind.

The department is well provided with the necessary field instruments, transits, levels, plane-table, etc., and each student is made familiar with their use and management by practical work in the field and draughting room, carefully planned to illustrate the actual practice of the engineer.

Included in the work of this department is a course in the mechanic arts, in which regular and systematic instruction is given by skilled instructors in the use of tools and machinery, and in processes. Patterns are made by the students from their own designs and drawings, of machines or parts of machines, and the castings are made, properly fitted together and finished according to the drawings.

EQUIPMENT.

The draughting rooms are lighted from the north, are furnished with adjustable tables, models, etc., are well ventilated and warmed, and are opened for work during the greater part of the day.

The engineering laboratory contains on Olsen's testing machine, arranged for tensile, compressive and transverse tests, a steam engine indicator, and other valuable appliances. It includes several shops, in which the students become familiar with the nature and properties of the materials of construction (iron, wood, brass, etc.) employed by the engineer, and with the processes of working them into the desired forms for their intended uses. They consist of

The machine shop, containing an excellent and complete assortment of tools, including four screw-cutting engine lathes, three speed lathes (simple and back geared), an iron planer, a complete universal milling machine, a set of milling cutters adapted for general purposes and for making other cutters, a shaper, a twist-drill grinder, two upright drills, an emery grinder, a mill grinder, a grindstone, fourteen vises (plain and swivel), fourteen lathe chucks (combination, independent, scroll and drill), a milling machine chuck, a rotary planer chuck, planer centers, a set of Bett's standard gauges, surface plates (Brown & Sharpe), three sets of twist drills, reamers, mandrels, screw-plates, taps and dies, lathe center grinder, a complete set of steam-fitters' tools

with pipe vise, ratchet drill, etc., together with the many necessary small tools, hammers, chisels, files, etc. Additions are constantly being made to this collection as they are needed, either by manufacture in the shops or by purchase. Power is furnished by a steam engine and boiler, the former fitted with an improved indicator, and the latter with the necessary attachments for determining its efficiency, etc.

The wood working shops, containing twenty benches with vises, and twenty sets of wood working tools, a grindstone and wood-turning lathes.

The smith shop, containing seven forges, anvils, and sets of blacksmith tools, bench and vise; and

The foundry, with its brass furnace and other equipments.

The details of the course vary somewhat from year to year; but in general, are represented by the following arrangement of the studies:

1. FRESHMAN CLASS.—*Machine shop practice:* Vise work, chipping and filing to line, scraping, fitting, tapping, reaming, hand-turning in brass and iron.

Drawing.—Special geometric problems, working drawings for the shop exercises, orthographic projections, shadows, brush work and tinting, machine drawing from copy and from measurements, gears, eccentrics, cams, pulleys, belting, etc.

Engineering.—Lectures on the use of tools, on the properties of materials, etc.

2. SOPHOMORE CLASS.—*Engineering:* Analytical mechanics of solids and fluids; descriptive geometry, including shades, shadows and perspective, and the careful construction of the more important problems; land surveying, with field practice and map drawing.

Machine shop practice. — Lathe work, turning, boring, screw-cutting, drilling, planing, milling, grinding, polishing, etc., construction of a project.

Drawing.—Working drawings for the shop exercises, sketches, drawings and blue prints for special work and projects, elements of machines, shadows and intersections, finished drawings.

3. JUNIOR CLASS.—*Before entering upon the work of this year the student must have completed course 3 in mathematics.*

Engineering.—Theory and practice of road surveying and engineering.

Geodesy.—Theory, adjustment and use of engineering field instruments, farm surveying, leveling, topographical, triangular and hydrographical surveying.

Applied Mechanics.—Friction and other resistances, stress and strength of materials.

Drawing and mechanism.—Topographical, structure and machine drawing, principles of mechanism, visits to and sketches of special machinery and structures.

Practical exercises in the field in the fall and spring months and in general laboratory practice, including the testing of metals and building materials, the setting up, testing and management of steam engines, boilers and machinery throughout the year; with occasional visits to mechanical establishments and to important engineering works in or near Philadelphia.

4. SENIOR CLASS.—*Before entering upon the work of this year the student must have completed course 4 in mathematics.*

Engineering.—Theory and practice of road surveying and engineering, continued: building materials, stability of structures, foundations and superstructures, bridge construction.

Applied Mechanics.—Practical hydraulics, practical pneumatics, general theory of machines, theory of prime movers, steam engines, turbines, etc., measurement of power.

Mechanism.—Principles of mechanism, of machine design, of the transmission of power, construction and use of tools.

Drawing.—Stone-cutting problems, topographical, structure and machine drawing, plans, profiles and sections of road surveys, working drawings.

Practical Exercises.—As in junior year, continued; tests of building materials, graduating thesis.

9. Tidioute Public Schools.

The following extracts from a personal letter under date of December 26, 1888, from the principal of the public schools of Tidioute, together with extracts from a newspaper article enclosed by him show the character of the work done here:

"I enclose a letter which I wrote some time since for our home paper. It furnishes, I think, the most complete description of the work of anything I have on hand. We have not yet done anything in 'iron work.' I am somewhat doubtful if we ever shall do much in this line. It seems to me *wood work* or 'sloyd' is the best calculated to serve the purpose of manual training. Our carpenter shop and lathe shop are both thoroughly organized and are doing very satisfactory work. The drawing is progressing nicely.

"Our flower gardens were a great success last summer and called forth many words of praise and admiration from all who visted them. This department I regard as one of the greatest æsthetic advantage in value and shall be much disappointed if our boys and girls do not make better husbands, better wives, and better citizens by this constant familiarity and association with flowers."

"EDITOR NEWS—DEAR SIR: Several inquiries have been made recently about the industrial annex of our public schools. I thought it might be of interest to the readers of the *News* to peruse a short article descriptive of the work now being accomplished. Many of our citizens have been kind enough to visit us this year, and have invariably expressed themselves not simply as being pleased but surprised at the excellence of the work. It would indeed be gratifying if more of our citizens should give us a call. The trouble, I think, is that it has been so long since the inception of the annex. and its development into a thoroughly organized workshop has been so slow that you have begun to think about it as something old and therefore not attractive. But does this sound as though it is old: A pupil who worked in the shop last year, on visiting it this year, said: 'I would not have known it to be the same room. If any one had described this I could scarcely have believed it.' Another said: 'Well, now, this looks like business. This is as well arranged as the city shops.' Similar expressions come from nearly all who visit the work. Citizens, you have something in the industrial line this year to be proud of, and I am surprised that you know so little about it. Don't let this state continue, visit the shop and drawing class, ask questions and become posted in what your own school is permitted to do through the praiseworthy liberality of your philanthropic neighbor toward the solution of this question of manual training and industrial education, which is now in our leading journals, educational and otherwise, occupying more space in its discussions than any other phase of school work. Concerning the work in the past, although various lines of work have been undertaken and

some good accomplished, yet it has not been until this year that the boys' department has been thoroughly organized."

DEPARTMENTS OF WORK.

We have now outlined five departments of work, in each of which some work is being accomplished. First, primary; second, drawing; third, floriculture or practical botany; fourth, girl's department; fifth, boys' department.

Primary.

In this department we teach such branches of kindergarten and other occupations as tend to make pupils careful, accurate and systematic; such devices as will vigorously develop the perceptive faculties, and thus broaden the foundation of intellectual power and physical skill.

We give lessons in stick laying, paper folding, cutting and pasting paper, tablet laying, mat weaving, card board embroidery, spool knitting, simple crochet stitches, knitting with two needles, simple designs in drawing, measuring with foot rule, clay molding and sand molding.

Time, one-half hour per day, material furnished, no extra teacher hired to help, but girls from the high school assist the regular teacher, two assistant girls for each primary room. The girls are always anxious to help the lower teachers as it helps them should they desire to teach afterwards.

Drawing.

In this department we endeavor to develop the conception of form through seeing objects, handling objects, making accurate measurements, etc. We represent the conception of form by paper folding, stick laying, drawing form of object examined, by dictation, by actual measurement, and by sketching. The foreman of the industrial shop, W. F. Barnes, has charge of this work, and aside from using Prang's industrial drawing series of text books and Prang's models, he imparts such instruction as will best fit the pupils for the advanced grades of work both in the shop and the mechanical drawing class.

In our high school we have a class of 32 in mechanical drawing, which, considering that they only work two hours per week, have done excellent work; many of the designs resembling printed work so much that many visitors have thus mistaken them. The work thus far has been confined chiefly to such practice exercises as tend to develop skill in the use of the mechanical drawing tools.

In this department will be included: First, plans and elevations of tools and machinery, by actual measurement. Second, isometric, or mechanical perspective. Third, development of the intersection of plain surfaces. Fourth, lettering. Fifth, geometrical drawing. Sixth, line and brush shading, with India ink. The entire course covers a

term of three years, embracing the above with free-hand drawing. Time, one hour each day, Monday and Tuesday afternoon.

Floriculture or Practical Botany.

In this department we have arranged in various ornamental designs six beds 30 x 40 feet. One of these is given to each room. In it they plant all kinds of flowering plants, chiefly hardy varieties. Boys and girls alike work the gardens. Our aim here is to cultivate a love for flowers and to teach their proper care and use. We think that by cultivating a few new varieties in each grade that. by the time a pupil passes through all the grades he will at least have become familiar with a few families, through which he may gain the acquaintance and friendship of some one that may be the means of leading him to a higher appreciation of the flower kingdom. The work on these gardens is done partly outside of school hours. They cost us last year about $60. This year they will not cost more than $30. All of which was raised by entertainments given by the pupils

The Workshop.

The carpentry division is now thoroughly organized and in it eighty boys receive one hour's insruction during three days of each week, Wednesday, Thursday and Friday.

The whole course covers three years' work. First year, carpentry; second year, wood lathe; third, iron, tin, etc., etc.

The facilities for this work consist of a shop two stories high 30 x 50 feet, with an L 24 by 30 feet. The ground floor is arranged for the blacksmith and tin shop. When it is completed it will be furnished with five forges, each furnished with a complete set of blacksmith tools, one boiler and engine, one large heating stove or furnace, which heats the whole building. On the second floor is the wood working shops, carpentry in one and lathes in another room.

The carpenter shop is furnished with ten benches, double. On each bench are two vises, a center board, on each side of which are suspended, one cross cut saw, one rip saw, one back saw, one hammer, one bevel square, one try square, one mallet, one pair of compasses, one gauge, one oil stone, one oil can, one small whisk broom for cleaning bench and dusting clothes.

Under the benches from each side are drawers and cupboards. In these are kept aprons, unfinished work, drawing books, and edged tools of which each bench has two sets of smoothing planes, one joining plane, and several chisels. There is also in the room a water sink and basins, a grindstone, and a blackboard on which is placed by the foreman a drawing of each exercise, and before the boys are allowed to make the piece they must first copy the drawing with its measurements into a book kept by each pupil for that purpose. There is also a large tool room or cupboard:

We do not compel any one to take this work yet we have only three boys who are old enough to go to the shop that do not avail themselves of the opportunity. Our aim in this is not alone, as some advocate, "so to train the hands and the eyes that the boys or the girls shall be more capable of earning a living," but in addition by bringing the pupil into contact with the material we would teach *things* rather than *theories*, *to do* as well as *how* to do. We believe that that education alone is complete which brings man into harmony with nature and at the same time develops within him such a power, physical, mental and moral, that by utilizing the forces and material with which he is surrounded, will lead to his highest development as a thinker and a doer.

XIX. RHODE ISLAND.

I. Newport Industrial School.

"NEWPORT, *October 22, 1888.*

"What we have done here in the industrial training for boys has been entirely of a private nature. We hope in another year to have it engrafted on our public school system. Perhaps I cannot answer your questions better than by sending you a copy of a circular we issued a year ago. We have continued the school during last year with an increased number of pupils, on the same plan. I think the school has shown that it has a good educational effect on the boys; it brightens them up mentally, they take great interest in the work and like to stay after hours. The effect on their other studies, most of the boys were from the public grammar or high schools was, I think, to guide their mental activity and develop their observing powers. We were anxious to develop the educational side of this training and to show to the people its practical result in that aspect. To those who were at all acquainted with our work, I think, the result fully justified our purpose. I send you a few prints of our 'shop' in order that you may better understand what we tried to do.

"Hoping that I have not wearied you with details of our work that may not be pertinent to your object, I am

"Very respectfully yours,

"WM. P. SHEFFIELD, JR."

RULES AND REGULATIONS.

1. Be in shop promptly at 7 P. M.
2. Have your working clothes on, and be at your bench ready for work without delay.
3. During practice hours give your attention to your *own work.*
4. Make no unnecessary conversation or noise.
5. Do not sit upon any of the work benches.
6. Keep your bench and tools neat and do not deface them in any way.
7. You will be held accountable for all the tools at your bench.
8. If any accident happens to a tool, or one is missing report the fact to the teacher immediately,
9. Give notice to the teacher whenever it is neccessary for you to leave the room.
10. You are not allowed to entertain visitors in the shop until you have permission from the teacher.
11. When the first bell strikes you are to quit work, clean up your tools and bench and continue cleaning in the shop, wherever it is most required, till the striking of the second bell.
12. Excuses for absence and tardiness must be rendered to the teacher immediately upon your return.
13. You are allowed but three tardinesses and two absences without sufficient excuse, if you exceed this amount it will be necessary for you to leave the school.

XX. SOUTH CAROLINA.

I. Brainard Institute.

CHESTER, S. C., *October 5, 1888.*

Dr. GEORGE W. ATHERTON:

DEAR SIR: * * * * * * * *

We have no reports of our industrial work. We have not as yet been able to obtain a press and type or we would publish our own reports, and have not means to get them printed. A few years since Dr. A. G. Haygood, General Agent Slater Fund, told us that if the citizens of Chester would furnish us the funds to put up a workshop worth $250 he would give us a like amount for tools. We obtained nearly that much in money and our pupils, with my help, nearly completed the building, 20x40, 1½ stories. It is probably worth $400 or $500. We have had no regular course of training, I being the only one to attend to it and having but little time to be used that way. But we have done our repairing, seated our old chapel, made tables, benches and desks. Now we have five of the young men at work on our new building. But for our workshop it would have been almost out of our power to have done the work we are now doing.

One of our young men, studying for the ministry, went into a destitute part during his vacation, and organized what help he could command and built a school house and later a church, and this without asking for much, if any, outside help.

Two of our present workers go out several miles each Sunday and teach a Sunday school. Wanting a bookcase, one of them made a nice one and painted it, doing the work out of hours, and gave it to them. I think some of the others may have helped him a little, as he had but little time to spare each day.

Our aim is to teach them so that they may repair or improve their homes, or construct new ones. * * * * * *

Respectfully,

(Signed) H. A. GREEN,
Professor Industrial Department.

XXI. TENNESSEE.

1. The University of Tennessee.

"The University of Tennessee" is one of the institutions receiving the benefit of the congressional act of 1862.

The departments of instruction comprise the following:

A. ACADEMIC DEPARTMENT.

At Knoxville.

I. The College of Agriculture, Mechanic Arts and Sciences, with the following courses of study:

(*a*) General science course.
(*b*) Latin science course.
(*c*) Course in agriculture.
(*d*) Course in civil engineering.
(*e*) Course in mechanical engineering.
(*f*) Course in chemistry.
(*g*) Course in mining engineering.

II. University, or Postgraduate Department.

1. With courses for the graduate degrees of M. A., M. S., and Ph. D.
2. With professional course leading to degree C. E., Min. E. and Mech. E.

B. PROFESSIONAL DEPARTMENT.

At Nashville.

(1) A course in medicine, leading to the degree of M. D., and
(2) A course in dentistry, leading to the degree of D. D. S.

The candidate for admission must be fifteen years of age. A good knowledge of arithmetic, English grammar and composition, geography and United States history is required for admission to the lowest class.

FOR EACH HALF SESSION OR TERM OF TWENTY WEEKS.

Tuition, in all departments (State cadets are free), ...	$20 00
Registration fee (State cadets are free), ...	10 00
Incidental, $6.00; room rent, $3.00, and library, $1.00 (paid by all), ...	10 00
Infirmary fee (which secures medical attention, medicine and nursing free, paid by all), except students whose parents reside here, ...	2 50
Deposit (returned if no damage is done), ...	2 50
Making a total, for State cadets, of $15.00; for other students of,	$45 00

From the opening of the new mechanical department, students working therein must pay a fee of $5.00 per half session for material wear and tear of tools and power supplied.

A course in mechanical engineering, beginning in the Freshman year, and extending through four years, in drawing and mechanics, with practice in wood-working, joining, turning, patternmaking, vise-work, power-machine work and designing, has just been established.

ADVANCED OR POSTGRADUATE WORK.

Students having completed the regular course in mechanical engineering, and wishing to thoroughly investigate some special branch of engineering, will be afforded instruction in the design and detail construction of compound steam engines (of double, treble and quadruple cylinder types); of high class pumping engines; of various types of hydraulic machinery in detail, such as cotton compress machinery, hydraulic cranes and hydraulic riveting and boiler plate flanging machinery; the thorough investigation of the latest developments in railway machinery, particularly the locomotive; in the design and theoretical investigation of the two systems of air compressing (wet and dry) for mining purposes; in mining machinery for coal, iron, copper, silver and gold mining; in machinery for refining the precious metal, and in appliances for smelting and reducing the baser metals.

In such postgraduate work the aim is not merely to teach abstract principles but to give such instruction by lectures and the working out of designs as will enable the student to have a thoroughly practical understanding of the subject investigated.

A special building for the mechanical school has been erected and equipped. It contains the following apartments:

First Floor.—Boiler and forge shop in a one-story wing; two large machine shops, tool room, office and wash room in the main building.

Second Floor.—Two large wood-working and patternmaking shops, office, tool and store-room.

Third Floor.—Two drawing-rooms, with windows and skylights, laboratory and instrument room, blue-print room and recitation room.

The building is equipped with boiler, engine, forges, hand and power wood working and machine tools, apparatus, models, etc.

All scientific and engineering students are required to take a course in mechanical drawing and shop work. Students in the mechanical, civil and mining engineering courses and the chemical course have a longer course in drafting and in forge and machine shop work. Even in the literary departments, where it is more difficult, this plan of instruction will be followed to a considerable degree. The general plan is to give every student in every class and course a minimum of six hours a week, in periods of one and a half and two hours each of laboratory, shop, farm, surveying, drafting or other practice work. To this an

average of four hours a week of military drill is to be added, making a total average of two hours per day for five days in the week of what is broadly called "practical exercises."

Students in the advanced classes and taking special or postgraduate courses may do, of course, much more than this amount of drafting, laboratory or shop work. All students who desire it are given opportunities and encouraged in every way to do as much practical work as possible.

XXII. TEXAS.

1 The Agricultural and Mechanical College of Texas.

The "Agricultural and Mechanical College of Texas" is also one of the institutions receiving the benefit of the congressional act of 1862.

The college was formally opened for the reception of students October 4, 1876.

There are two regular courses of study and practice leading to degrees and extending through four years each. They are identical for the first year, thus giving the student the advantage of elementary training in subjects that are of equal importance to every one and affording opportunity for intelligent choice between the courses as continued separately through the three succeeding years. In the last year, or first class, there is a still further specialization by which the student may, in the agricultural course, vary his studies with reference to obtaining either of two degrees, that is, bachelor of science (B. S.) or bachelor of scientific agriculture (B. S. A). In the mechanical course a similar specialization is provided for by which the student is given the choice between the degrees of bachelor of civil engineering (B. C. E) and bachelor of mechanical engineering (B. M. E.).

All regular students must pursue either the agricultural or the mechanical course, and there is no course of instruction which is not industrial.

ADMISSION

To enter the college an applicant must be in his sixteenth year or at least must have attained a degree of physical and mental advancement corresponding to that age.

The mental attainments necessary for entering upon the courses of study comprise a fair knowledge of arithmetic as far as proportion of descriptive geography and of elementary English grammar and composition.

Tuition is free. The total expense for the year of nine months is $150.

In addition to the above a charge of five dollars is made to cover possible damage to the college property, and the cost of chemicals and other materials used by the students.

The mechanical course in detail is as follows:

FIRST YEAR—FOURTH CLASS.

(*Figures indicate hours per week.*)

FALL TERM.

Mathematics, 5; English, 5; Stock Lectures, 3; Horticulture, 2; Shop, 4; Drawing, 4; Drill, 5.

WINTER TERM.

Mathematics, 5; English, 5; ———, 1; Stock Lectures, 1; Agriculture, 1; Zoology, 3; Shop, 4; Drawing, 4.

SPRING TERM.

Mathematics, 5; English, 5; Botany, 4; Agriculture, 1; Practice, 6; Drill, 3; Drawing, 2.

SECOND YEAR—THIRD CLASS.

FALL TERM.

Mathematics, 5; Mechanics, 4; English, 4; Physics, 3; Practice, 4; Drawing, 4; Drill, 5.

SPRING TERM.

Mathematics, 5; Mechanics, 5; English, 4; Physics, 3; Practice, 4; Drawing, 4.

WINTER TERM.

Mathematics, 5; Mechanics, 5; English, 4; Physics, 3; Drill, 3; Practice, 4; Drawing, 4.

THIRD YEAR—SECOND CLASS.

FALL TERM.

Mathematics, 5; Chemistry, 4; Mechanics, 2; Engineering, 2; English, 2; Languages, 2; Drill, 3; Practice, 6; Drawing, 4.

WINTER TERM.

Mathematics, 5; Chemistry, 4; Mechanics, 2; English, 2; Engineering, 2; Languages, 2; Tactics, 2; Practice, 6; Drawing, 4.

SPRING TERM.

Mathematics, 5; Mechanics, 2; Chemistry, 4; Surveying, 2; English, 2; Languages, 2; Drill, 3; Practice, 6; Drawing, 4.

FOURTH YEAR—FIRST CLASS.

(*For the Degree of Bachelor of Mechanical Engineering.*)

FALL TERM.

Mathematics, 4; Mechanics, 5; Geology, 2; Languages, 3; Drill, 3; English, 2; Practice, 6; Drawing, 4.

WINTER TERM.

Mathematics, 5; Geology, 2; English, 2; Mechanical Engineering, 5; Languages 2; Military Science, 1; Practice, 6; Drawing, 4.

SPRING TERM.

Mathematics, 3; Mechanical Engineering, 4; English, 1; Astronomy, 2, Languages, 3; Physiology, 2; Gov. Science, 2; Practice, 7; Drawing, 3; Drill, 3; Graduation Thesis.

"The department of mechanical engineering is intended so as to combine theory and practice that, after deriving a theoretical knowledge of a subject from the text books of standard writers, the student may go into the shop and apply that knowledge in a thoroughly practical manner. With this theoretical preparation the mind grasps the salient points and avoids the difficulties of the more practical part of the work. The work is carried on by the aid of practice in the shops and drawing room, and by text books and lectures.

" First the machinery of transmission is taken up and discussed, and especial attention paid to shafting, belts, speed pulleys, gear wheels and kindred subjects. These lead the way to the higher forms of mechanism, and later the steam engine in its general principles and various forms is studied and discussed.

" As stated above, the work in the class room is supplemented in every possible way by showing the student the practical application of these principles in the machinery used at the college and neighboring places.

" Before graduating from this department, each student must place in the hands of the professor in charge, a thesis which treats of some mechanical subject, and which shall be declared satisfactory by him.

SHOPS AND SHOP WORK.

" The carpenter shop is situated in a two-story frame building 83x34 feet. Here each student has his own set of tools to care for, use and keep in order. The machine shop is a one-story brick building 80x35 feet, and in connection with it is the blacksmith shop 20x35 feet.

" Here the student receives practical and systematic instruction, beginning with the simplest exercises and gradually working up to those of a more difficult character which involve greater skill. Each of these when finished must reach a certain standard of perfection before the learner can pass on to the next, thus insuring a knowledge of the principles by which the work is accomplished. The wood working depatrment is subject to the same requirements, and here, as in iron working, the first exercises are of the simplest character, while the latter ones demand increased skill on the part of the workman."

XXIII. VIRGINIA.

1. The Virginia Agricultural and Mechanical College.

Professor Jas. H. Fitts gives the following report of mechanical work in this institution, founded on the land-grant act of 1862:

"Blacksburg, Va., *October 2, 1888.*

"Systematic instruction in drawing and the use of wood-working tools has been given for two years, in the use of iron-working tools for one year. The method adopted is the same as that in use in the St. Louis Manual Training School, the Miller Manual Labor School and others. The course runs through three years, and averages six hours of work per week.

"Our shops are fairly well fitted out with machine and hand tools, but we have no foundry as yet. The department is in charge of the professor of mechanics, with two assistants, instructors in wood work and iron work.

"In so short a time, we cannot look for great results. Students have, from the beginning, shown much interest in their work, and this interest is on the increase. At the State fair last year, a suite of bedroom furniture was exhibited which took first premium. This year exhibit is made of both iron and wood work, as well as working drawings, at the Richmond exposition.

"The public at large knows little of our work, but since a start has been made in the right direction, our board of visitors have been as liberal in making appropriations for the department as the limited means at their disposal allows, thereby showing their confidence in its success."

President Lomax, in transmitting the foregoing report and speaking generally of the work of the department, says:

"I am glad to state, I feel much encouraged. The students who have passed through the shop work, find no difficulty in getting employment in the Roanoke machine works, and other shops. This has been a great incentive to them. Our board appropriates $1,000 per year for new machinery; and we hope to soon have a complete shop."

2. The "Miller Manual Labor School."

"The Miller Manual Labor School of Albemarle" was founded by Samuel Miller, of Albemarle, Virginia, for the purpose, as stated in his will, of establishing a place "wherein, at all times, there shall be fed, clothed and instructed in all the branches of a good, plain, sound English education, the various languages, both ancient and modern,

agriculture, and the useful arts, and wholly free of expense to the pupils, as many poor orphan children and other white children whose parents shall be unable to educate them (the said orphans and other children being residents of the said county of Albemarle), as the profits and income of the funds herein devised and bequeathed will admit of."

In accordance with this bequest, on the death of Mr. Miller in 1869, the executor turned over to the "Miller fund," as denominated in the will, stocks and bonds amounting to over one million of dollars, the income and profits of which were for the establishment and perpetual support of the Miller Manual Labor School.

This fund is held in trust by the board of education of Virginia.

The school is managed and controlled through the agency of the county court of Albemarle. The court appoints "annually, two intelligent, respectable, and well-educated gentlemen," whose duty it is to select and employ, whenever necessary, competent and suitable teachers for the school (subject to the approval of the county court), and to visit the school quarterly, examine into its condition minutely, and make written report thereof to the court.

"The district school trustees of the respective districts of the county of Albemarle, select and designate the children of the county who come under the requirements of Mr. Miller's will for admission into the school. From this list, made and revised by the school trustees every six months, the court appoints the pupils of the school. It is to be noted that only children who are residents of the county of Albemarle can be appointed to the school. Moreover, they must be selected as coming under the requirements of Mr. Miller's will by the school board of the district in which they reside before the court can appoint them to the school. These pupils when appointed to the school are clothed, fed, taught and cared for wholly at the expense of the school. In October, 1878, the first pupils were admitted into the school. The school began with twenty pupils It was then quite difficult to find children whose friends were willing to have them appointed to the school."

In accordance with an order of the court in August, 1884, a department for the instruction of girls was organized under the authority and control of the superintendent. Under this order the first girls were admitted in November, 1884.

Conditions for the Admission of Pupils.

1st. Each pupil shall be fed, clothed, instructed and cared for in accordance with the provisions of Mr. Miller's will. 2d. They shall be governed and controlled by the superintendent exclusively, assisted by the other officers of the school, in accordance with such laws and regulations as may be adopted by the board of visitors and approved by the county court. 3d, They shall remain at the school subject to

its laws and regulations during the time that shall be determined by the district board of school trustees, unless dismissed in accordance with the laws and regulations of the school. 4th. The parents, or guardians, shall, upon their entrance in the school, relinquish all right or claim to control or govern them during the time that they shall be required, in accordance with the above conditions, to remain at the school. 5th. They are appointed by the county court, subject to the condition that they shall not remain at the school after they are eighteen years old, save in case of unusual merit, when an exception may be made upon the recommendation of the officers of the school and the board of visitors.

"July 1st, 1888, there were 242 pupils, the largest enrolment at any one time.

"*Primary Department.*—In this department, the pupils are taught reading, writing, intermediate arithmetic and primary geography. Under the conditions of Mr. Miller's will, no entrance examination is required. Hence many must begin at the lowest point. Very few are able to enter above the primary department.

"*Higher Department.*—This department is divided into six classes, to each of which is given one year. The studies in these six classes are as follows, viz:

Sixth Class.	Arithmetic.	English.	History.	Geograp'y.	House and Farm Work.
Fifth Class.	Arithmetic.	English.	History.	Geograp'y.	Printing and Farm Work.
Fourth Class.	Algebra.	English.	Latin.	Botany & Physiol'y.	Farm Work and Shop Practice.
Third Class.	Geometry, Algebra.	English.	Latin.	Chemist'y.	Drawing and Shop Practice.
Second Class.	Algebra, Geometry.	Physics.	Latin and German.	Geology, Mineral'y.	Drawing and Shop Practice.
First Class.	Trigonometry.	Mechanics.	Latin and German.	Botany, Entomo'y.	Drawing and Shop Practice.

"After completing intermediate arithmetic in the primary department, the pupils are given a careful and thorough course in arithmetic, algebra, geometry, and plane and spherical trigonometry. They also are given some instruction in conics. This course, taken in connection with their book-keeping, drawing, mechanics, physics, and shop practice, gives them a most substantial mathematical foundation upon which to build.

"SHOP WORK.

"In the department of practical mechanics instruction is given by the director, aided by an instructor in wood, one in iron, one in forging

and foundry work, and one in drawing. To complete the course takes four years, one in wood work, one in forging and foundry work, one in iron work, and the last year in advanced work in one of these three departments. Fifteen hours per week is devoted to shop work through the entire time. Drawing is taught thoroughout the four years for seven and a half hours per week, and in each year is allied to the branch of shop work that the pupil is taking. The first year is taken by the boys in the fourth class of the regular school course (the first class being the graduating class). Here they learn by a systematic course of exercises the use of the various hand tools and appliances used for wood work, the principles of a variety of joints used in construction, and how to make them. They also become familiar with the lathe and its tools and wood-working machines generally, such as are used in carpentry and cabinet work and patternmaking. At the end of the year they are able to make articles of furniture, such as washstands, tables, etc.

"The second year in this department is taken by the boys of the third class. Here they are trained in forging and foundry work. They learn first in forging the use of tools on lead instead of on hot iron, which greatly facilitates the work of a beginner. It is not long before they can handle iron itself with a measure of skill. In foundry work, they also commence with alloys, etc., before molding iron, though they later learn to charge and manage the cupola and to do a fair variety of molding.

"The third year is taken by the boys of the second class in the machine shop, where they first learn the use of the tools, etc., by regular exercises. Before the end of the year they are able to construct different mechanisms, etc., of a creditable character.

"In the fourth year, having previously gone through all the departments, the student is required to make a specialty of one of them, and follow up advanced work in it.

"Drawing, as previously mentioned, is taught throughout the four years, and each year bears an intimate relation to that year's shop practice. It is begun with very simple free-hand drawing, and later on the use of instruments is gradually acquired. The drawing is never from plates, but from objects, either real or imaginary.

"In addition to this regular course in shop practice, etc., a time is set aside in each department for regular instruction of a more special character for those boys who, on account of advanced age or other cause, will be unable to graduate.

"The instruction in physics, mechanics, and electricity, is also given in this department. The course in physics is interesting, thorough, and decidedly practical, being well illustrated throughout by careful experiments. In mechanics, which is made (as it should be) to bear a close relation to manual training, shop practice, etc., the pupils are taught the principles, etc., involved in the various operations they

are taught to perform. Electricity is taught in direct connection with the dynamos, storage batteries, regulators, resistance boxes, etc., of the electric light plant, aided by a collection of electrical apparatus, and the pupils are required to become sufficiently familiar with them to manage them intelligently, and to make dynamos, motors, converters, etc."

XXIV. WISCONSIN.

1. "The University of Wisconsin."

"The University of Wisconsin" receives the benefit of the act of Congress of 1862.

It embraces:

I. The College of Arts.
II. The College of Letters.
III. The College or Law.

The College of Arts embraces the general science course and the special science course preliminary to the study of medicine, together with the technical departments of agriculture, of civil, mechanical, mining and metallurgical engineering, and of pharmacy.

The College of Letters embraces the ancient classical course, the modern classical course, the English course, the special course preliminary to the study of law and journalism, and the special courses for normal school graduates.

ADMISSION.

All candidates for admission to the collegiate, engineering and special courses are examined upon the following studies: English, mathematics, arithmetic, algebra, through quadratics and plane geometry, *Geography*, civil, political and physical, history of the United States.

In addition to the above, the requirements for admission to the mechanical engineering course are the following:

Natural philosophy, physiology, botany, solid geometry and German (the equivalent of Sheldon's Short German course and twenty lessons in any standard German reader).

For the German required an equivalent amount of French may be substituted. If French is thus substituted, it is a required study through the freshman year instead of German, which is otherwise required.

Admission is also granted upon accredited certificates.

FEES.

Tuition for residents of the State of Wisconsin is free; for non-residents, per term, $6.

Students working in the laboratories are required to make deposits of from $5 to $30, to cover the cost of instruments and materials used by them. An account of the same is kept and the amount of the deposit not used is returned to the student at the close of his term of study in the laboratory.

COURSE IN MECHANICAL ENGINEERING.

Freshman Year.

FALL TERM.

Mathematics, higher algebra.
German, reader.
French, elementary.
Draughting, elementary, five hours weekly.
Practical Mechanics, ten hours shop work weekly.

WINTER TERM.

Mathematics, theory of equations, graphic algebra, determinants.
German, reader, or,
French, elementary.
Rhetoric, practical.
Draughting, elementary, five hours a week.

SPRING TERM.

Mathematics, trigonometry, descriptive geometry.
German, scientific reader, or,
French, elementary.
Draughting, descriptive geometry problems, five hours a week.

Essays, declamations and elocution, twice weekly throughout the year.

Military drill in fall and spring terms. Military tactics (optional) in the winter term.

Sophomore Year.

FALL TERM.

Mathematics, analytical geometry, descriptive geometry.
Mechanics, elementary.
Chemistry, lecture and laboratory practice.
Draughting, descriptive geometry problems, ten hours a week.

WINTER TERM.

Mathematics, differential calculus.
Engineering, machine construction.
Physics, experimental lectures.
Chemistry, inorganic analysis.
Draughting, elements of machines, eight hours a week.
Practical Mechanics, five hours shop work a week.

SPRING TERM.

Mathematics, integral calculus.
Engineering, machine construction.
Physics, experimental lectures.
Chemistry, inorganic analysis,
Draughting, elements of machines, eight hours a week.
Practical Mechanics, five hours shop work a week.

Essays, declamations and elocution, weekly, throughout the year.

Military drill in fall and spring terms. Military tactics (optional) in the winter term.

Junior Year.

FALL TERM.

Engineering, machine construction.
Mechanics, analytical.
Physics, electricity and magnetism.
Draughting, ten hours a week.
Practical Mechanics, ten hours shop work a week.

WINTER TERM.

Mechanics, analytical, graphic statics.
Applied Mechanics, thermodynamics.
Draughting, problems in graphic statics, ten hours a week.
Practical Mechanics, five hours shop work a week.

SPRING TERM.

Engineering, theory of steam engine.
Mechanics, mechanics of materials.
Draughting, hoist ng mnchinery, ten hours a week.
Practical Mechanics, ten hours shop work a week.
Five essays and one oration required during the year.

Senior Year.

FALL TERM.

Engineering, construction of steam engine.
Metallurgy, fuel, iron and steel.
Draughting, pumps, steam engine, ten hours a week.
Practical Mechanics, ten hours shop work a week.

WINTER TERM.

Engineering, hydraulic motors.
Mechanics, mechanics of machinery.
Astronomy, practical (elective).
Draughting, steam engine, ten hours a week.
Practical Mechanics, ten hours shop work a week.

SPRING TERM.

Mechanics, mechanics of machinery.
Astronomy, practical (elective).
Draughting, steam engine and thesis, fifteen hours a week.
Practical Mechanics, ten hours shop work a week.
Three essays and one thesis required during the year.
A thesis is required for graduation, which must be submitted to the Professor of rhetoric as well as to the professor of mechanical engineering.

In elementary mechanics the aim is to impart clear notions of the elementary principles of mechanics, as a preparation for the study of physics, or the more advanced work in analytical mechanics. Correct notions of fundamental principles and of the language of the science are regarded as of greater importance than facility in the solution of problems by rule or formula.

During the fall term, junior year, the work in analytical mechanics covers the main principles of the subject of statics. The work of the winter term deals mainly with the kinematics and dynamics of a particle, the principles of work and energy, and moments of inertia. In this course it is possible to develop only the beginnings of the science of analytical mechanics, but sufficient ground is covered to give the student of engineering a foundation for all ordinary technical applications of mechanics, and to furnish to those whose tastes lead them in that direction, a ground work for future study of the more advanced theoretical portions of the subject.

The study of graphic statics is taught by lectures. The graphical method of determining strains and moments is first applied to framed

structures, especially roof trusses, considering both the dead load and the wind pressure. The method is then applied to various pieces of machinery, especially the determination of the dimensions of shafts, axles, cranks, etc. The work in the recitation room is here largely supplemented by the work in the draughting-room.

The problems studied in the class-room are worked out in the draughting-room with great accuracy, and the different pieces of machinery are drawn in detail.

Mechanics of materials embraces both theory and practice. The resistance and elastic properties of the most important of the materials of engineering are studied from a theoretical standpoint, and students are familiarized with these properties by tests made in the laboratory. The testing laboratory has been equipped with a Tinius Olsen & Co.'s testing machine of 50,000 pounds capacity, with tensile, compressive and transverse testing tools, those for transverse testing being capable of breaking full-sized pieces up to thirty feet in length, and with a Riehle Brothers cement tester.

Mechanics of machinery embraces the kinetics and kinematics of the different machines, and is essentially the mechanics of constrained motion. The subject is first treated in a general way, then numerous examples are taken from special machines, that the study may be of practical value to the student.

Thermodynamics covers those principles of the mechanical theory of heat which are a necessary preliminary to the study of the theory of heat engines.

The lectures given on machine construction furnished the necessary rules and formulas for calculating and designing the various elements of which machines are made up. Beginning with the immovable parts like the rivet, the screw and the key, the course passes on to the movable parts, like the journal, the shaft, toothed gearing, pulleys, etc. The course is very complete, the theoretical as well as the practical elements being duly considered.

The study of the steam engine extends through two terms. It is taught by lectures exclusively during the spring term, the theory of the steam engine and of the boiler being then especially considered. Practical, yet scientifically correct, formulas for calculating the principal dimensions are given. During the fall term the subject is taught partly by lectures, partly by recitations. The steam engine is then considered more from the practical side. In connection with this study the students will, together with the professor, take part in a thorough test of some steam engine and of the boiler furnishing the steam. The department will very shortly be fully equipped for conducting these experiments.

The study of hydraulic motors is taught principally by recitations. The general subject of hydraulics is first taken up, in which the flow of water through orifices, pipes, canals, over wires, etc., is determined,

and the experimental coefficients are discussed. After this, the hydraulic motors, especially the turbines, are treated in a systematic way. A short discussion of pumps finishes the study. It is the intention to have the students carry out hydraulic experiments in the new laboratory which is being fitted up.

DRAWING.

In elementary drawing the student is first taught the use of the brush in tinting various plane and curved surfaces with India ink. He then learns the well-known system of round writing and the various kinds of lettering. The remainder of the time is spent by students in mechanical engineering, in making a number of tracings of details of machines, and by the students in civil, mining and metallurgical engineering in topographical draughting with pen and colors.

The instruction in the draughting room follows closely the class room work in descriptive geometry, and comprises a large number of problems relating to the different phases of the work. Most of the problems are not found in the text-book and the student must therefore solve them independently. Great stress is laid on the accuracy of the drawings, as well as on the character of the line work, as this study furnishes the best training for a future draughtsman.

In the course in elements of machines working drawings, mostly full size, are made of various elements of machines, as pillow blocks, hangers, couplings, the various kinds of toothed gearing, spur, bevel and worm wheels, pulleys, etc. These details of machines are, to a great extent, designed by the student himself. The drawings are made in every particular, so as to serve as working drawings in a factory. For the sake of gaining practice they are required to be tinted in the various conventional colors. The dimensions of the various parts are calculated. Eight hours a week during the winter and spring terms of the sophomore year, and ten hours a week during the fall term of the junior year.

The course in machine construction embraces the designing and draughting of machinery, and is supplemental to the work in the class-room and the workshop. At present, one term and a half are spent in designing some kind of lifting machinery. The remainder of the term is occupied with the design of an automatic cut off steam engine. Besides the general plan and an elevation of the machine designed, working drawings of the details of the various parts are required. During the fall term of the senior year the students are also required to design some kind of model which they are to make in the machine shop before graduation.

PRACTICAL MECHANICS.—MANUAL TRAINING.

With the ample accommodations afforded by the new buildings, the instruction in all branches of this department is made thoroughly systematic and practical. The instruction and practice in the shops are given in classes and examinations are

held at the end of each term. All students of mechanical engineering are required to give 940 hours time to shop practice during the four years of the course.

Bench Work in Wood.—A systematic course in the use of the plane, saw, gouge, bit and similar tools. It embraces such joint work as is involved in building constructions and furniture. A short lecture precedes each new operation. First part of fall term, two hours per day, 50 hours.

(Required of all Freshmen in Engineering.)

Machine Work in Wood.—Systematic training in the use of the gouge and chisel in plane and ornamental turning, in hard and soft wood. Middle of fall term, two hours per day, 50 hours.

(Required of all Freshmen in Engineering.)

Pattern Work and Molding.—Practice in making patterns and in molding. The selections of patterns are made with reference to best illustrating the principles involved in pattern construction and in the operations of molding. Last part of fall term, two hours per day, 50 hours.

(Required of all Freshmen in Engineering.)

Hand Work in Iron.—A systematic course in iron work with the hammer, chisel and file at the vise. Winter term, five hours weekly, 60 hours.

(Required of all Sophomores in Mechanical Engineering.)

Surface Plate Work with File and Scraper.—Systematic training in producing flat surfaces and lines of precision with the file and scraper. Spring term, five hours weekly, 55 hours.

(Required of all Sophomores in Mechanical Engineering.)

Forge Work.—Training in all the fundamental features of forge work, as drawing, upsetting, bending, welding, tempering and tool making. Fall term, five hours weekly, 60 hours.

(Required of all Juniors in Mechanical Engineering.)

Machine Work in Iron.—Practice on the engine lathes, in connection with which are taught the elementary features of boring, turning and screw-cutting. Fall term, ten hours weekly, 90 hours.

Tool Making.—The methods of tap and die making for cutting screw threads are the leading features. Some instruction in brass work is also given. Winter term five hours weekly, 60 hours.

(Required of all Juniors in Mechanical Engineering.)

Machine Construction.—Practice in the manufacture of machinery, involving calculations of the cost of their production. Spring term, ten hours weekly, 110 hours.

(Required of all Juniors in Mechanical Engineering.)

The work of this course for the seniors in mechanical engineering is similar to that of the preceding but includes the use of plane-surfacing machines, and requires the highest skill of the student in fitting, etc. Fall term, ten hours weekly, 150 hours.

Model Designing and Construction.—Practice in the designing and the construction of models, in connection with which training self-dependence is given. The responsibility is imposed upon the student of designing some piece of machinery which is illustrative of the principles previously taught, and requires pattern-work, molding, forging and machine work. Winter term, ten hours weekly, 120 hours.

(Required of all Seniors in Mechanical Engineering.)

Model Construction and Testing.—The work in this course is devoted to completing and perfecting the models, and to such tests and experiments with them as will demonstrate the principles involved in them and develop their excellencies and defects. The field of invention is open to the student in this and the preceding course. Spring term, ten hours weekly, 85 hours.

(Required of all Seniors in Mechanical Engineering.)

The engineering departments occupy the first floor and basement on the north side of the new science hall.

The basement rooms of the engineering department consist of an engineering laboratory, an engineering museum, a reading room and one recitation room. In the laboratory are to be found a testing machine made by Tinius Olsen & Co., of 50,000 pounds capacity, and fitted with tools for tensile, compressive, torsional and trans-

verse strains; a cement testing apparatus, made by Riehle Bros., of 1,000 pounds capacity, with the necessary clamps and apparatus for measuring and molding; high and low level tanks of large capacity, fitted for experimenting on and determining the flow of water through orifices and pipes, and over weirs. There is also a row of steam coils arranged to test and compare the value of different forms of steam pipe covering; a ten-horse power vertical steam engine supplies power in the laboratory, and is so arranged that it can be run for experimental purposes as a high or low pressure engine, and also at various speeds. There are also friction brakes of large and small capacity, and two transmitting dynamometers which furnish the means for carrying out a great variety of tests. The laboratory closely joins the boiler house, and connections will be so made with the boilers that a constant record of their performance can be kept. In addition, the laboratory is being supplied with the necessary tanks, weighing apparatus, pyrometers, calorimeter, etc., for making complete tests of the economy and capacity of the boilers.

There are also a ten-horse power experimental turbine wheel and a small dynamo-electric machine, which have been made by students.

The engineering musuem will contain a collection of specimens of all the various engineering materials, including selected test specimens; also a considerable number of models of roof and bridge truses will be gradually added, made by the students from their own designs.

On the first floor the largest room is the main draughting room, which contains desks for eighty students. Distributed throughout the room in cases is a very large and varied collection of general working and detailed drawings of a great variety of engineering structures and machines, which illustrate the latest and best principles. There is also a collection of models, illustrating problems in descriptive geometry and in stone cutting.

The lecture rooms are fitted with cases containing a good collection of drawings of typical structures and machines, and numerous models for the illustration of mechanical motions, etc.

MACHINE SHOP.

The machine shop is new and affords excellent facilities for mechanical practice. It embraces a main machine room 78×41 feet, equipped with five engine lathes, a polishing lathe, a 24′ wood lathe, a grinding lathe, a shaper, a planer, a milling machine and two drilling machines; a room for smaller machines, 32×30 feet, furnished with an engine lathe, a milling machine, a polishing lathe, a drill; a carpenter shop 44×39 feet, supplied with a planer, two saws, a shaper, a sticker, a mortising machine, a tenoning machine and a scroll saw; a forge room 24×36 feet, provided with ten forges and their equipments, supplied with a Sturtevant blower for the blast and an exhaust fan for ventilation; a foundry room of the same size whose equipment will consist of a cupola, brass furnace and core oven, with the necessary small tools; a wood work room 45×44½ feet, supplied with benches, carpenter tools, and wood turning lathes sufficient for the accommodation of twenty-four students and a pattern room 30×32 feet, furnished with the requisite tools.

2. Sparta Public Schools.

SPARTA, WIS., *September 28, 1888.*

GEORGE W. ATHERTON, LL. D., *State College, Pa.:*

DEAR SIR: * * * In response to your inquiries relative to documents regarding manual training, I would say that we have none, as our board have taken no direct action in the matter. But I, as superintendent, have introduced a sort of a system which seems to be the best we can do under the circumstances. It was an outgrowth of our drawing. A few years ago after we had introduced Prang's system of drawing or rather the constructive and representative part of it, it occurred to me that it would be an excellent plan to encourage our

pupils to take working drawings home and make articles there according to the drawing. We did so supposing that we were the first to engage in it, but found to our surprise that other schools in Ohio, Massachusetts, etc., were doing the same about that time. We added to the home work until all grades had something to do. The home work was optional. In addition to this we had an exhibition of anything pupils cared to make at home, the girls doing all kinds of handiwork, sewing, cooking, etc., the boys work in wood and iron. Our first exhibition was a revelation to our patrons. We only claimed for our scheme that it was a stimulus to our pupils to induce them to use their hands and brains outside of school, to develop much of the mechanical ingenuity which lies latent in every mind. We further claimed that when the parents saw their children interested in some effort to construct things, they would endeavor to aid them by their advice and procure tools for them as fast as they saw that the children desired them. Then we thought also that such a system persevered in for years would tend to develop much of the latent mechanical ingenuity of children before they were fifteen years old, so that we could tell clearly whether a child possessed any aptitude toward any mechanical trade or not.

We f rther reasoned that the ordinary system of manual training which fits up a shop for high school pupils and does not provide some work for the pupils of the lower grades is a mistake. The work of the kindergarten should be continued to the high school, and we thought our system did it. Furthermore, we have come to the conclusion from our experience that this home work, unsystematic as it is, is far superior to the child in *mental training* than the one which provides for the work to be done at school under an instructor.

The child is thrown more on his own resources to overcome obstacles than when at school. He must use his own mind or fail. Also, it puts on the parent what is his duty to do—to provide instruction in hand work for his child or give it himself. Thus it secures the coöperation of parents with the school. Then, again, our system is inexpensive, and can be carried out in every school in the land, and I have been satisfied to continue it until something can be arranged upon which advocates of manual training can agree better than they do now.

This much for our theory. Our plan briefly stated is this: Home work in constructing objects according to working drawings provided at school.

Home work upon anything for an exhibition to be held once or twice a year. For this exhibition, articles formed from the class drawings are taken. Also everything else representing hand-work. Girls are encouraged to do *plain* sewing rather than fancy work; cooking rather than paintings; darning and patching rather than embroidery.

Now for results.

First. Parents turn out in crowds to visit the exhibition and I have yet to hear the first note of adverse criticism. It meets their approbation.

Second. In a great many instances, parents have provided their children with lathes, tools of various kinds, so that many of our boys are liable to do very creditable work. At our last exhibit two boys had complete steam engines of iron in working order. They made the patterns, moldings, castings, and did all the work.

Third. Many girls are stimulated to learn to do plain sewing and cooking, and their mothers teach them or provide instruction because their children want it. * * *

Yours truly,

(Signed) L. H. CKARK,

Principal.

3. The Whitewater State Normal School.

The catalogue of this institution for 1887–8 states that "A small workshop, begun a few years ago as an experiment, affords limited means for instruction and practice in the use of wood-working tools, and has proved a valuable adjunct of the scientific department. Members of the class in physics spend four hours each week, for twenty weeks, in learning the use of the fundamental tools, and how to construct simple apparatus; the purpose being to make those who pass through this training, especially the young women, more independent and self-helpful under the limitations which surround the average teacher.

INDUSTRIAL TRAINING FOR GIRLS.

The introduction of branches of manual training especially designed to meet the needs of girls has not advanced so far or so rapily as the similar movement for boys; yet work in sewing, cooking, industrial drawing, etc., has been begun in many places, and the results have everywhere proved of the most gratifying and promising character. Without attempting any full enumeration of the places in which these exercises have been introduced, we present a few instances which will sufficiently indicate the method and scope of the work, and the wide field which it opens on both the economical and the educational side.

1. BOSTON, MASS.

Public Schools.

Two school-kitchens for the instruction of girls from the neighboring grammar schools, who come to the kitchens once a week for a two-hours' lesson, in classes of fifteen at a time, were opened in October, 1885. In the first, which has taken the name "Boston School Kitchen Number One," were one hundred and fifty girls from the upper classes of four schools, including a few from the Horace Mann school for the deaf; in the other, one hundred and twenty-five girls from three schools. The cost of fitting up and operating these schools was at first met by two public-spirited ladies. The plan is for the city to assume the running expenses after one year. The master of the first school reports that "the success attending the work has been complete, the one hundred and fifty girls belonging manifesting great interest and enthusiasm in the performance of all their duties; and, although many of them are obliged to come long distances, the attendance has been excellent. The same programme—bill of fare—is continued throughout a week, each class having one lesson; and it is sent to the various schools represented, where it is placed conspicuously before all the scholars, with directions informing them for what price the prepared food can be purchased. An opportunity is thus presented for each pupil to buy, at cost of materials, the dishes cooked by herself. Thus is gained a two-fold advantage. In a pecuniary and economical view it provides in a large measure for the expense of supplies, and for the proper disposal of the food without trouble or waste; but the benefit conferred upon the community by this distribution of scientific cookery (and economical marketing) among

the homes is beyond calculation. The pecuniary consideration is lost sight of, as but of little moment, when compared with this approach to the living center of the homes."

It is not "fancy cooking" at all that these girls are taught; it is plain cooking of the common and inexpensive articles of food. The art of making plain living agreeable, of making limited means ample, of making the home always pleasant and attractive with modest outlay—this is what these girls are acquiring. Thousands of homes now can be improved by giving the daughters this instruction in the domestic arts; and thousands more of future homes will be better and happier in consequence of such instruction. What better protection can society have against the ravages of intemperance and crime than homes, however humble, made happy and attractive by housewifely thrift and good taste? In the miseries of bad house-keeping the home too often yields its sway to the saloon.

In November, 1886, the chairman of the committee on manual training reported:

In the school kitchen No. 1, ten classes, of 15 girls each (each class receiving one lesson per week), have received 29 lessons.

The school opened in October 4, 1886, with the same number of pupils, from the same schools as above mentioned.

Over 700 persons, from nearly all parts of the country, visited this school during the year. One of the ladies kindly volunteered to pay again this year the expenses of the school because of the reduction by the city council of our appropriations. With our limited means we have been able to establish but one new school this year—a cooking school in South Boston.

The cooking school in South Boston, or Boston school kitchen No. 2, is located on the first floor of the Drake primary school. The kitchen is larger than those hitherto in use. We can accommodate 20 girls per lesson or 400 per week.

One hundred and thirty-four girls attend a private school of cookery on North Bennett street, under the superintendence of the committee. Thus all the girls in the schools of the city proper and South Boston have the opportunity to receive a course of 20 lessons in cookery.

These schools deserve great consideration from the committee. They are certainly popular with the people. Their usefulness reaches at once the home circle and compels appreciation. The pupils are proud to be helpful at home. Their parents are much pleased with their welcome assistance.

We have found masters, teachers, parents and pupils all heartily interested in this work. In the beginning there were teachers who had misgivings lest the manual work would interfere with the proper school work. We find no such teachers now. All the manual workers hold good rank in their schools.

Petitions for schools of cookery have come to us from Dorchester,

Roxbury and East Boston. In Dorchester we are offered a school kitchen fully equipped if the school committee will carry it on.

The following illustrates the work done in school kitchen No. 1. It is merely the bill of fare of one of the many dinners served in that school kitchen:

BILL OF FARE

of dinner served at Boston school kitchen No. 1, June, 1886:

Potato soup; croûtons; baked fish with parsley sauce; mashed potatoes; shoulder of mutton, bone and stuffed; macaroni with white sauce; vegetable salad with boiled dressing; hot rolls; apple snow; crisped crackers; coffee. Ten persons served. Cost, $1.91; 19$\frac{1}{10}$ cents each.

The object of all public education is the development of the ability and character of each boy and girl. All good ability and character is profit to the community. Therefore the thorough development of the facilities for good of every boy and girl is most desirable. Manual training impresses upon every pupil the necessity of thoroughness, for all good work, all good results. A habit, a plan of work, insensibly grows on every pupil and goes with them into all school work. It is to be expected it will go with them, after their studies in our schools are ended, into their work in the world. There they will find a school, too, under much harsher rules.

In school kitchen No. 1, for the first term, the expenses were as follows:

Cost of provisions and fuel for 150 girls, 20 lessons, ...	$42 50
Cost of provisions and fuel per girl, 20 lessons, ...	0 28$\frac{1}{3}$
Cost of provisions and fuel per girl per lesson, ...	0 01$\frac{4}{10}$

Number of dishes cooked at home by pupils, 10,740.

For the second term:

Cost of provisions and fuel, 150 girls, 16 lessons, ...	$33 00
Cost of provisions and fuel per girl, 16 lessons, ...	0 22
Cost of provision and fuel per girl per lesson, ...	0 01$\frac{3}{8}$

Number of dishes cooked at home by pupils, 12,100.

Total number of dishes cooked at home by pupils during both terms, 22,840.

Total number of pupils during the year, 300.

Of 700 families who have been represented at this school during 1885-1886, and to June, 1887, 692 have expressed themselves very much in favor of the school. Only 8 families have been indifferent or not favorable.

At the close of the year 1887, four school kitchens had been established in the city. All except one being supported by public-spirited ladies.

The chairman of the committe, in his report of December, 1887, says:

It will be noted that to-day all the girls in the schools of the city,

proper, South Boston, Roxbury, and West Roxbury, have an opportunity to receive a course of twenty lessons in cookery. The girls of a large part of Charlestown and East Boston, and a part of Dorchester, enjoy the same advantages.

To-day 900 girls are attending our schools of cookery. During the current school year, 1,800 will receive a good education in this line of work. In addition to the school kitchen, the kind-hearted ladies of the North Bennet street industrial school maintain, for the benefit of the children of our city, classes in carpentry, printing, shoemaking, and modeling.

SEWING.

The following summary statement is quoted from the report of the United States Commissioner of Education, for 1886 87.

"At Boston, where the study has been most thoroughly introduced and organized, even to the extent of holding weekly meetings of the sewing teachers for conference, the course of instruction is, in brief, as follows: After the child has been taught how to select thread and needle, to thread the needle and to hold it, it is put to basting together a bag-apron, in which to keep the work; then it is taught to backstitch, to hem, and to overcast the seams of the basted apron. This method has the advantage, says the supervisor of sewing, of interesting the child, since it is employed in making something that it is to wear. The material is almost invariably furnished by the pupil; the garment is prepared by the teacher and sewed under her direction. Great interest is manifested at the homes of the children, and cases are known in which the child has instructed the mother in the lesson that it has learned at school. In a few schools dressmaking has been introduced; simple dresses, however, are made in all the schools. In concluding her remarks the supervisor says:

"There is no doubt that the habits formed in connection with learning to sew have an important influence on the life and character of the girls and their homes. It may be confidently asserted that the influence of the sewing is healthful and lasting upon the mind and character of the pupils, and on that account, no less than for its material utility, it deserves the respect and encouragement of the community. As a department of school work it is second to none in the success which it has attained and the interest it has enlisted in and out of the school room.

"The inexpensiveness of the materials (in Boston costing about $200 a year), the cleanliness, and particularly the simplicity of the work, permitting the pupil to remain at her desk, render sewing much less difficult to introduce and maintain as a duty than cooking, which not only requires appliances that are inappropriate to a school room, but an activity that is incompatible with the order that is exacted there."

2. BROOKLYN, N. Y.

Pratt Institute.

Courses in cooking, sewing, millinery, art embroidery and dress-making have been established for girls in Pratt Institute.

COOKING.

The cooking school was opened January 20, 1888, with a class of twenty ladies. Other classes were organized, and in March there were three classes with twenty-five pupils in each. A course consists of twelve lessons, one lesson of two hours' duration being given weekly. One hundred and eight pupils have been connected with the cooking-school. Many applicants have been unable to gain admission, but in the future there will be accommodations for a much larger number of pupils.

The evening classes are reserved for self-supporting women, the day classes are open to all.

The rooms of the cooking school are on the sixth floor of the main building. They are excellently ventilated by large sky-lights with numerous swinging sashes in the roof, besides window-sash and side-wall ventilators. In the center under the sky light are two large cooking-tables, twelve feet long by four feet wide. Each is furnished with ten gas burners for cooking, and ten drawers with shelves below. Every drawer and set of shelves is supplied with a complete assortment of cooking utensils, so that twenty people can work at the same time. All the appointments of a well-ordered kitchen are here found, such as hot and cold water, galvanized iron sinks, range, stove, closets, dressers, refrigerator, etc.

There are three courses in cooking, of twelve lessons each, advancing regularly from the simplest to the more elaborate dishes. Every pupil is required to give evidence of her thorough acquaintance with the elementary before passing to the higher course. A practical application of the principles taught is insured, since each pupil works out with her own hands the receipts given her. The instruction comprises lessons on the building and care of a fire, proper modes of measuring liquids and solids, of boiling meats, eggs and vegetables, broiling and roasting meats, of making soup, puddings, and, most important of all, bread; in short, the principles and practice of good, plain, wholesome cooking. Every pupil is urged to try all the dishes at home, and a record is kept of the number thus made

In connection with every lesson a brief lecture or explanation is given by the instructor upon the chemical and nutritive properties of

the materials used, the changes produced by cooking, etc.; and when a pupil has completed a full course of thirty-six lessons, it is expected that she will not only be able to prepare all varieties of wholesome and appetizing food, but will also have a good understanding of the properties of the various food materials, their values as nutritive agents, the chemical changes involved in the processes of preparation, and other matters necessary to thorough and intelligent work.

In front of the cooking-rooms is the lunch room, where a simple meal, well served, is furnished at noon and at evening for a small sum. This is intended primarily for the use of the teachers and students connected with the institute.

SEWING.

The sewing class opened February 23, 1888. Twenty-four pupils were present at the first lesson, and at the second twelve more entered, enlarging the class to such an extent that it was necessary to divide it. An evening class began work March 9, and a class for school children was opened Saturday morning, April 7.

The large room on the south side of the third floor of the main building is used for the sewing classes.

The instruction comprises all kinds of hand-sewing, from simple overhanding to button-holes, hem-stitching, feather stitching, and instruction in machine-sawing. Cutting and making plain garments from pattern is also taught after pupils have acquired a knowledge of hand-sewing.

MILLINERY.

Two classes were organized April 19, and a third April 25, for instruction in millinery. In these, as in all other classes, the principles taught will be practically applied, each pupil making during the course an entire hat or bonnet, in which good taste and good workmanship shall be combined.

ART EMBROIDERY.

All applicants for admission to classes in art embroidery are advised to complete a short course in drawing and color as indispensable to good work. A knowledge of hand-sewing is required for entrance, since a pupil must first learn to use the needle in elementary work before taking up the complex art of embroidery. It is desired to train women who shall be able to originate good designs both as to color and form, and not be forced to continually copy the designs of others.

DRESSMAKING.

March 19, 1888, three classes of twelve pupils each began a course of ten lessons in dressmaking, each class receiving one lesson of two hours' duration per week. One class meets in the morning, one in

the afternoon, and one in the evening. April 10, another class of twelve was formed and began work. Many applicants have been unable to enter, but hereafter a much larger number can be accommodated.

Large tables for drafting, tracing and cutting, comfortable chairs, sewing machines, blackboard, and closets for storing materials, afford every facility for doing the best work.

A systematic course of dressmaking is offered—a knowledge of hand and machine sewing, as well as some experience in making simple garments from pattern, being required for entrance. Each pupil, under the guidance of the teacher, learns to fit, make and drape an entire dress for herself or others from measure during the course.

It will be the aim of the teacher to include in her instructions the principles and ideas of good taste in dress, that it may be not only a dress well fitted, well made, and tastefully draped which the pupil has produced, but also one best suited to her form and coloring, thereby endeavoring to train dressmakers who will have a sense of the value of the true artistic element in dress, combined with thorough workmanship.

DEPARTMENT OF DOMESTIC SCIENCE—FEES.

Cookery.—Day classes, \$3.50 each for first and second courses, and \$5 00 for third course.

Evening classes, \$1.50 each for first and second courses, and \$2.00 for third course.

Sewing.—For course of twenty-four lessons:

Day classes,	\$4 00
Evening classes,	2 00
Day classes for children,	2 50

Dressmaking.—Courses consist of twelve lessons:

Elementary day classes,	\$5 00
Elementary evening classes,	3 00
Advanced day classes,	10 00
Advanced evening classes,	7 00

Millinery.—Twelve lessons.

Day classes,	\$4 00
Evening classes,	2 00

3. CLEVELAND, OHIO.

Public Schools.

The superintendent of the Cleveland public schools gives the following account of the cooking school of that city:

"Although this school did not become a part of the manual training school until the close of the year for which this report is made, yet its importance and success have been so marked that I submit the following relative to its history and work:

"In the fall of 1884, a few young ladies, possessed of a commendable missionary spirit, opened a kitchen garden in one of the basement rooms of Unity Church, about twenty pupils being in attendance. The school grew and prospered beyond expectation, so that early in 1886 it was found necessary in order to extend the work so as to meet the demands to organize on a more permanent basis. The 'Cleveland Domestic Training Association' was the result. In February of this year the cooking class was formed and opened at No. 479 Superior street, seventy girls being enrolled the first term. By permission of the board of education free classes were formed from the pupils of Rockwell school. More than seventy pupils desired to enter, but less than fifty could be accommodated.

"In September, 1887, the cooking department of the association became a regular branch of the Cleveland manual training school. A sum of money was set aside to defray the expenses of teaching a certain number of pupils from the city public schools. By this arrangement four hundred and twenty-one girls received ten lessons each free of cost. The benefits of this school seem so marked that it is to be hoped that better quarters and more ample accommodations may be secured. This school was among the first to be organized in this country. Already a number of others, similarly organized, have been established in the larger cities.

"I append the lessons for one term:

"*Menu first week.*—Lamb chops, cranberries, mashed potatoes, oatmeal, baked apples.

"*For second week.*—Potato soup, scrambled eggs, turnips in white sauce, apple tapioca.

"*For third week.*—Fish balls, milk toast, apple shortcake, coffee.

"*For fourth week.*—Mixing and baking bread and biscuit, tomato soup, steamed rice.

"*For fifth week.*—Oyster stew, corn cake, toasted crackers, griddled cakes, lemon syrups.

"*For sixth week.*—Corn beef hash, frying out fat, rye muffins, doughnuts.

"*For seventh week.*—Beef stew, dumplings, chocolate, cookies.

"*For eighth week.*—Creamed cod fish, French toast, cottage pudding, sauce.

"*For ninth week.*—Collops or Hamburg steak, Lyonnaise potatoes, apple pie, gingerbread.

"*For tenth week.*—Green pea soup, fried fish, potato balls, floating island and plain cake.

"This enterprise opens up a field of very great interest, second to none in point of practical importance. There is no attempt at "fancy cooking." On the contrary, the sole aim is to teach the girls how to make good bread, how to cook plain every day articles, how to prepare and serve a good, palatable, wholesome meal from ordinary materials. and how to do this in the most economical and satisfactory manner. Notes are taken and recipes copied. The pupils do actual cooking under the immediate supervision of skilled teachers. Not only so, but the home kitchen becomes the 'practice school' of the interested learners, thus transferring the benefits of the school to hundreds of homes throughout the city. Says Superintendent Seaver of Boston, in speaking of the cooking school of that city:

"'The art of making plain living agreeable, of making limited means ample, of making the home always pleasant and attractive with modest outlay—this is what the girls are learning.'

"All this is equally true of Cleveland. A practical knowledge of the domestic arts can result only in the elevation and refinement of the home in which this knowledge is applied. This enterprise is a legitimate outgrowth of the new education. It is a clear illustration of the obedience of the hand to the dictate of the will for the accomplishment of a definite object. It is a realization in a small way of the desire to have something practical taught in the schools. Viewed from any standpoint, it is an enterprise worthy of encouragement."

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4. LAFAYETTE, INDIANA.

Purdue University.

The "School of Industrial Art" in Purdue University has special attractions for young women and has produced some excellent work, as illustrated by the plate already given on page 105. The object of the school and the course of study in full are as follows:

The object of this school is, in addition to giving a good general education, to give a practical knowledge of object drawing in outline, light and shade, and color: of linear perspective; of orthographic projection, or the drawing of plans, elevations and sections; of woodcarving or clay modeling, including historical ornament and decorative design.

FRESHMAN YEAR.

Industrial Art.—Twenty-seven weeks, five hours per week, and eleven weeks, fifteen hours per week. Model drawing in outline. This includes free-hand outline drawing from round geometrical solids, as cylinders, cones, vases and crockeryware; from straight line objects, as cubes, prisms, crosses and pyramids; also, the drawing of the above objects in groups and their application in drawing chairs,

tables, sofas and buildings. Linear perspective.—This subject includes the working of about one hundred problems illustrating the principles of parallel, angular and oblique perspective, and showing how to put into perspective any object. Orthographic projection.—The instruction in this subject includes the drawing of about one hundred problems, illustrating the principles for making "working drawings," including plans, elevations, developments and intersections. Light and shade.—Under this head model and object drawing in light and shade will be taught, using first the crayon and the stump.

Geometry.—Twenty-seven weeks, five hours per week.
Algebra.—Eleven weeks, five hours per week.
Rhetoric.—Thirty-eight weeks, three hours per week.
Elocution.—Twenty-seven weeks, one hour per week.
French or German.—Twenty-seven weeks, five hours per week, and eleven weeks, two hours per week.

SOPHOMORE YEAR.

Industrial Art.—Twenty-three weeks, five hours per week; four weeks, ten hours per week; and eleven weeks, fifteen hours per week. Light and shade.—Further practice will be given under this head in drawing from casts and in using the brush Color.—The instruction here embraces the theory of color, including the principles of harmony and contrast, and practice in water colors, as applied to object drawing and still life.

Higher Algebra.—Twelve weeks, five hours per week.
Trigonometry.—Eleven weeks, five hours per week.
English Literature.—Nineteen weeks, three hours per week.
History.—Nineteen weeks, three hours per week.
Physics.—Thirty-eight weeks, four hours per week.
French or German.—Thirty-eight weeks, two and one-half hours per week.
Elocution.—Nineteen weeks, one hour per week.

JUNIOR YEAR.

Industrial Art.—Thirty-eight weeks, ten hours per week. Students who have satisfactorily completed the work of the freshman and sophomore years in the school of industrial art are supposed to have a fair knowledge of drawing, at least sufficient to enable them to take up some special line of work, as wood carving or clay modeling. Wood carving.—At first the sharpening and the proper handling of tools are taught. Incised and low relief carving is then practiced, followed by medium and high relief work, as skill in the use of tools may warrant. Students begin to carve easels, tables, sideboards, etc., soon after entering the carving class. Historical ornament.—An outline of the principal styles of historical ornament, together with illustrative examples, will be given with wood carving or clay modeling in the junior year, during the second and third terms.

Chemistry.—General chemistry, twenty-seven weeks, eight hours per week; and applied chemistry, eleven weeks, eight hours per week.

Elective Studies.—Juniors must elect two of the following:

1. *Analytical Geometry and Calculus.*—Thirty-eight weeks, five hours per week.
2. *Literature and History.*—Thirty-eight weeks, four hours per week.
3. *French or German.*—Thirty-eight weeks, four hours per week.

SENIOR YEAR.

Industrial Art.—Thirty-five weeks, eight hours per week. During the senior year, students may continue wood carving in connection with decorative design; or, if a sufficient number desire it, they may continue the course in clay modeling in connection with decorative design; or they may take an advanced course in drawing, including casts and the human figure. Clay modeling.—The study and practice of this subject is a good preparation for work in wood, iron, stone, marble, silver or gold. It is indispensable to the first-class plasterer, stone cutter and sculptor. After some practice in modeling simple ornaments, leaves, fruits, flowers, etc., the student

is allowed to work on such subjects as will probably be of use in his future profession—it may be tiles, pottery, architectural terra cotta, or the human figure, Decorative design.—In this course the principles of flat and sculptured ornamentation are studied and applied in designing surface decorations of all kinds. Advanced drawing.—This course may include the balancing of the human figure as a whole, the expression of character in the face, including caricature, drawing the figure from casts and the living model. Crayon or the brush may be used.

Human Physiology.—Nineteen weeks, four hours per week.
Geology.—Sixteen weeks, four hours per week.
Psychology.—Nineteen weeks, four hours per week.
Political Economy.—Sixteen weeks, four hour per week.
Elective Work.—Thirty-five weeks, four hours per week in literature, or additional art work, ten hours per week.

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5. NEWPORT, R. I.

Industrial School for Girls.

Miss Katherine P. Wormeley who has devoted herself with great earnestness to the introduction of the industrial idea into the public schools of Newport, furnishes the following interesting account of this school:

"At the close of the school, June 30, 1888, we had taught in all classes since July 1st, 1887, 510 girls. The girls come to us, at 4.15 P. M. after the session of the public schools; usually the girls from each school house come in a body. The high school girls and some of the older girls come to evening classes at 7.30 P. M.

"The present school year began September 3d, 1888, with 140 girls in the cooking classes, 75 in the cutting, fitting and dressmaking classes, 136 in the sewing classes, of which 72 are also in the household work classes.

"The cooking classes (fifteen to each class) are taught on the general system of the Boston school kitchen, with changes to suit our wishes.

"The cutting, fitting and dressmaking classes (ten in each), are taught by the Root 'Magic Scale' system.

"The sewing classes (24 and 36 in a class) are taught on a system of our own.

"The household work classes (36 in a class) are taught on Saturdays only, by lessons prepared by us—the original idea coming from Miss Huntingdon's system. This class shows remarkable results in families.

"We have at this moment no vacancies in any class. Girls are never absent unless from illness or some actual cause. The public school teachers tell us that the girls are so anxious to get off at 4 P. M. when the session closes that they take good care not to deserve to be kept after school. We have never had any girl troublesome or really inattentive in the school. In saying this, I must state that our discipline is quite as strict as that of the public schools. At the outset I felt the importance of this, and have enforced it. Of course the teachers are

friendly and kind with the children (in fact we are all friends together) but, for instance, no girl ever speaks without permission, or, except in the sewing classes, without standing up. This may seem a small matter, but I regard it as important in a school which has no *rights* over the children and no power to enforce discipline or attendance.

"We take no children under ten years of age.

"The fact that we never have a vacancy for which applicants are not waiting, and the character of the letters which I receive from parents, when occasion calls them forth, are sufficient to prove the demand, and the strong feeling of parents, for the instruction given at this school.

"I answer many letters of inquiry from all parts of the country about the school. To several (in Illinois, Iowa, western New York, Maryland) I have sent details of our methods, sets of cooking and household work lessons, etc."

Under date of November 4, 1888, she writes:

"I am very anxious that the school shall become part of the public school system—partly because it will not be permanent in any other way; partly because I do not think it proper that a limited class of persons should continue to pay, year after year, for an education so eagerly sought by the pupils of the public schools; and partly because I, personally, am fully convinced that public education has reached a stage where, for its own health's sake, it needs the element of training for actual life."

Under date of September 1, 1888, Miss Wormeley made public the following additional statement:

"The industrial school for girls opens on Monday with one hundred and ten pupils in the cooking school; sixty in the cutting and fitting classes; one hundred and thirty in the sewing and household work school. There is room for ten more in the cooking school and twenty more in the cutting and fitting classes. The sewing classes are over full. During the last term of the school seventy-seven girls in six classes made 4,432 dishes in their own homes. This does not include the number made by two 'advanced classes'; twenty girls finished well-fitting and well-made dresses.

"The school, thanks to the liberality of its friends, is secure of support, as follows:

Estimated monthly expenses (for the ten school months),		$250 00
Annual subscriptions made to me,	$2,475 00	
Donations made to Miss Hunter, in March, 1888,	564 00	
		3,039 00
Balance on hand June 1, 1888,		$1,082 92
Estimated monthly expenses (school closed June 23),		250 00
E. and O. E. balance on hand July 1, 1888,		$832 92

6. NEW YORK CITY.

Public Schools.

From the reports and manual:

"In accordance with your wish for a brief statement regarding the results of the manual training course which was introduced here in May last, I send the following:

"The cooking has been enthusiastically received by the pupils, and never have I seen more thoroughly interested workers than there are in that branch of the course. Many report from week to week, the results of home work, thus giving proof of the hold it has upon them, and parents are constantly signifying their gratification at its introduction.

"The study of the chemistry of cooking, and an intelligent application of this knowledge cannot fail to work a complete revolution in the homes of thousands who now suffer from ignorance of the simplest laws governing the proper preparation of food.

"Its educational advantage is manifested in the gradual development in self-reliance and judgment in pupils who are particularly weak in these respects, and in a corresponding improvement in those who are naturally stronger.

"The children who have instruction in sewing are also much interested.

"In the initial stages of this subject, when the judgment must be used, it doubtless has its value as a means to the desired end, but the future must show whether it is of sufficient value to have school time given to it in so many of the grammar school grades. It will do much towards fostering a spirit of economy, and therefore, must be recognized as a useful branch.

"My limited experience in the form and drawing course, already shows me that it cultivates ingenuity, increases the executive power, makes close observers and accurate thinkers as well as doers.

"I think this is the most important part of the manual training course, for it must be the foundation of the perfected structure.

"My experience thus far in industrial education in our schools leads me to conclude that the course of instruction in sewing and cooking is beneficial to the pupils of our schools, inasmuch as the systematic and philosophic methods laid down for both of these departments must necessarily result in inculcating habits of attention, neatness, and judgment, which will benefit children not only in these special branches, but in all others during school life, and which will prove of inestimable value in after life."

COOKING.

THIRD GRADE.

General Notes.

Materials.—Materials which compose the tissues of the human body: table of compound elements; of chemical elements; water the chief constituent; how these tissues are constantly in process of wasting; effects of muscular action, voluntary and involuntary; thinking, etc.

Repair.—The wasting of the tissues makes food necessary. How the tissues are constantly renewed, repaired, sustained.

Alimentation.—The food must contain the same elements as those which are being lost from the body.

Cooking.—Few solid materials, excepting certain fruits, are naturally ready for digestion and assimilation. Cooking prepares for digestion, especially of many vegetable substances. It must also make food palatable.

Nutriment.—Nutritive value of different kinds of foods largely dependent upon cooking. Elements supplied from vegetable foods; from animal foods; chief vegetables that supply a certain element, such as starch, sugar, sulphur, lime, etc.

The four compound groups.—The mineral group—water, salt, etc.; the starch and sugar group; the fats group; the albuminoid group.

Nutrititive value not dependent alone upon the quantity of one or more elements, but rather upon the combination of several elements.

Compound foods generally the most nutritious.

Examples: *Milk,* chief of natural foods, contains water, sugar, butter, caseine, various salts, etc. *Bread,* chief of cooked foods, contains water, sugar, starch, gluten, phosphate of lime, etc.

The four chief chemical elements of food.—Carbon, hydrogen, oxygen and nitrogen.

Related Facts, Physical and Chemical.

Heat, practical sources of, for cooking; kinds of fuel; wood, anthracite, bituminous coal, charcoal, gas.

What combustion is.

Effects of heat on water, *boiling*; temperature of boiling water at sea level in open vessel; less at elevations; why? temperature at "simmering"; popular mistake about this; what becomes of the added heat; practical uses of this knowledge; how temperatures higher than 212° may be obtained; when necessary or useful; effects of tight or heavy lid of a closed vessel; why a vessel no longer boils over on removing the cover; effects of a strong solution of salt upon the boiling point; temperature of steam; practical uses of these facts.

High temperatures of flames—effects of draught in increasing them—moderate white heat, 1,300°—(a poker put into a kitchen stove will often show more than this)—melting point of iron, 2,786°—blast furnace, 3,300°—what the clinkers in a fire chamber tell.

Physical effects of heat on the albumen of eggs; on that of flesh; on starch; on the gluten of bread; proper temperature for various purposes.

Effects of boiling as applied to fresh meats—to meat for soups—to salt meat—effects and changes previously wrought by the salt, or, how salted flesh or fish differs from fresh—boiling as applied to vegetables—when steaming is preferable.

General principles of baking, roasting, boiling, frying, etc.

Chemical effects of overheating—on bread—what burned or badly scorched bread has become—effect on other foods—special effects on fats, particularly in frying; the decomposition produces a very acrid substance, *acroleine:* injurious effects upon the stomach.

Principle of raising bread, biscuits, etc.,—air or carbonic acid set free, and expanded by heat.

Baking powders—their proper ingredients—cheapness and poisonous effects of those containing alum—carbonic acid directly set free from the chemicals and retained in small bubbles by the gluten.

Yeast—what it is—simple account of the growth of the yeast plant; changes wrought by it in the *sugar* of the flour—products—alcohol and carbonic acid—alcohol escapes in baking—carbonic acid forms the vesicles—why bread or cake "falls" in the oven if the heat is not properly maintained.

Leaven—what it is—how it acts.

Effects of boiling water on yeast or leaven.

What causes the crust of pastry to be light and flaky.

How eggs may make cake "lighter."

Food of infants—of convalescents.

Avoidable causes of dyspepsia.

The germ theory—its importance—why milk and certain cooked foods sour and ferment; why flesh and fish spoil; why fruit decays. Effects of cold or ice; of heat; of salt, sugar, borax, salicylic acid, etc., in preserving food.

Apparatus—stoves, ovens, etc.,—care of drafts and dampers. Lined ovens. Importance of keeping all clean, inside and out.

Utensils—absolute cleanliness indispensable—care necessary when vessels of iron, tin or copper are used—effects of iron on tea and coffee—of acids and fats on copper—verdigris—the condition of water that has been for hours in a lead pipe—dangers of old plumbing; health and even life often dependent on a knowledge of these things.

Purchasing food—discrimination as to wholesome and unwholesome; how to know fresh vegetables—fresh meats; fresh eggs; limed eggs; young poultry; to distinguish lamb from mutton; fresh fish; when salted beef has been properly cured.

The choice of parts—the butchers' names for parts of an ox—how to know good beef—the choicest parts of a poor animal are inferior as food to any part of a good animal.

Methods and practice in cooking—involving simple practical applications of facts and principles taught.

SECOND GRADE.

As in third grade.

SEWING.

EIGHTH GRADE.

Suggestions.

Use blackboard to illustrate stitches as in primary grades. See that the girls' work is rolled up by itself and marked distinctly. The teacher must now insist that the stitches shall be made small as well as even.

As a review of the work of the primary grades, it would be well to have each pupil make a thimble bag of white muslin, and sew on it her name, written upon a strip of muslin. When the work is put up, this bag can be pinned to it with thimble in it.

Review hems and bias fells: Follow these with the *French seam*. This is a form of seam much used in certain kinds of undergarments. It is made by first running the seam on the right side of the work, turning it over, and stitching it on the wrong side. This gives strength and is neater than an overcast seam.

Gathering.—Work must be prepared by dividing it into halves and quarters, marking divisions by putting in pins. This will be of service in insuring evenness when the work is put on the bands.

Coarse thread should be used and be broken off in pieces not too long. Leave about a quarter of an inch of the raw edge; then gather by taking up two threads and skipping four threads. Draw up the stitches and fasten the thread by twisting it around a pin; then with a coarse needle or a pin place each gather straight, holding the muslin between thumb and forefinger.

To put gathers into a band it is necessary first to baste on the band most carefully. Divide it to correspond with the divisions in the gathers, marked by the pins. The band should then be hemmed on both sides, the stitches being made small enough to take in each gather.

SEVENTH GRADE.

Button-holes.—Use as coarse a thread and as fine a needle as possible. The child should be taught to cut, by a thread, a hole a little larger than the button, to take two stitches at the start, and hold the muslin along the first finger lengthwise. Then let the hole be overcast closely, barring the ends about two threads deep. Commence the button-hole stitch at the bottom of the left side. This stitch is made by passing the thread around the needle after it is in position for drawing through the cloth. Stitches should be close and even, one thread between each stitch and the following one. Four stitches should be taken at the end for strength.

Sewing on Buttons.—Use double thread, concealing the knot under the button; let two stitches be then taken across both ways, making lines on the wrong side; then pass the needle several times through the button. To finish off, let the thread be wound around the button, and fastened with two stitches on the wrong side.

Patching.—Calico or striped muslin is useful for this. Cut the whole even by the thread; the pieces to be put in should be larger than the hole. It must then be taken from the inside and fastened on corner of hole, running it in except at the corners, where back stitches should be taken. In turning the corner, a little notch must be made with the scissors close to the stitches, to prevent drawing, and to make the corner pointed. The seam should then be felled down.

SIXTH GRADE.

Herring-bone Stitch.—This stitch is used specially for sewing down flannel seams and for flannel patching.

The stitch is commenced at the left, which is the opposite end of the work to that at which all other sewing begins. Fasten the thread at the top of the seam, by a small stitch; then bring it down about a quarter of an inch, slanting it to the right; make then another small stitch—cross the thread and bring it back to the top.

The stitches at the top and bottom should be a quarter of an inch apart, and so placed that each of those of the lower row will be directly under the middle of the open space between two of those of the upper row.

Darning Stockings.—For this stitch get the children to bring old coarse stockings from home; use darning cotton and needle. Trim off the edges of the hole, pass the thread under the end of the hole, then with it go back and forth from top to bottom, taking up woven stitches of the stocking, and running into the stocking about a quarter of an inch. Then from side to side pass the thread, taking up alternately one of the end to end threads, so weaving the threads at the center. Tears and cuts should be treated in much the same way.

FIFTH GRADE.

Work of previous grades reviewed, and followed by *tucking*. Great care should be exercised in creasing the tucks. A piece of paper should be cut with a notch of the same size as the proposed width, the muslin be laid on the desk or a slate, and folded over with the paper to designate width. Crease the fold with the nail of the right-hand thumb; then with fine running stitches sew the fold. Turn it over and with forefinger scratch the sewing on wrong side, which will lay the tuck down smoothly.

Gussets are specially used in finishing off gentlemen's shirts. Take a two-inch square piece of muslin, cut it into two equal triangles; turn down rough edges of one of these triangles, called a gusset, also the edges of the seam into which this gusset is to be placed. Take the middle corner of the piece and fit it to where the sewing of the seam has stopped. Overhand it down half an inch each side with small stitches. Turn the gusset over on the wrong side of muslin and hem it down neatly.

FOURTH GRADE.

A system of taking measures upon geometrical ideas is here introduced. Also, with use of blackboard for illustrations, paper patterns of waists and undergarments are cut and afterwards fitted to figure. In this grade the principle of drawing from scale and measurements will find practical application.

7. PHILADELPHIA, PA.

Public Schools.

Superintendent MacAlister, under date of March 25, 1886, makes the following statement:

"Sewing was introduced as a regular branch of instruction into the public schools of Philadelphia in the spring of 1885.

"Instruction is given to the girls in all the grades above the primary —that is beginning with the third year of the school system.

"Special teachers are employed. These are assigned to districts comprising adjacent schools, and perform their duties in accordance with programmes which are arranged by the principals of the several girls' schools and the sewing teachers.

"The following course of instruction must be regarded as merely tentative. The work has been carried on under it for about seven months, but it will not be authoritatively adopted by the board of public education until it has been thoroughly tested and modified as experience may dictate.

"In starting, it was found necessary to begin the work in all the grades at the lowest stage of the instruction, and while the older pupils have made much more rapid progress than the younger ones, none of the classes have yet reached the highest stage of the course.

"Instruction in sewing is also given in the girls' Normal School, where it was introduced five years ago, to 1,000 girls from 14 to 17 years of age. At present, about 25,000 girls are receiving instruction in sewing in the public school of the city."

COURSE OF INSTRUCTION IN SEWING.

SECONDARY SCHOOLS.

Fifth Grade—Five Months.

Position of the pupils while engaged in sewing.

The proper use of the thimble finger, first finger and thumb of the right hand. Position of the left hand for holding the work. Drill in the same.

Exercises in the action of taking a stitch and drawing the thread through the material.

Drill in the threading of the needle. (Needles and thread *may* be given out at the beginning of the lesson.)

Turning, basting and sewing plain hems. Attention to be given to accuracy in width of hems and size of stitches used in basting and hemming. Correct use of the scissors (paper may be supplied for this purpose).

Over-seaming on turned edges; the raw edges may be turned in and hemmed down.

If more material is needed than that furnished by the board of education, towels, wash-rags and similar articles may be hemmed.

Sixth Grade—Five Months.

Questions and exercises in the use of thimble, scissors, threading the needle, the direction of the needle as used in basting and sewing a hem. Time for these exercises, five minutes.

Over-seaming, with explanations and exercises in joining a new or broken thread.

Seam, composed of one running and one back-stitch; the raw edges to be overcast.

Work brought from home may be table-napkins, towels, bags, desk-covers and pillow slips.

Seventh Grade—Five Months.

Questions on position, the proper use of the thimble and scissors. Exercise in threading the needle. Questions on the direction of the needle when used in basting, hemming and over-seaming. Time for this exercise, five minutes.

Seam made by half back-stitching; the raw edges to be overcast.

Reversible seam.

Plain fell, sewed with running stitches, strengthened by an occasional back-stitch and finished with hemming.

Back-stitched seam over cast on the raw edges.

Patching commenced.

Work brought from home may be towels, table-napkins, pillow-slips, ruffles to hem, bags and worn articles that may need patching.

Eighth Grade—Five Months.

Questions on the work of lower grades. Time for this exercise, five minutes.

Plain fell repeated. Gathering, placing, or stroking the same.

Sewing the gathers into a band, using half-back stitching; the band finished with hemming.

Darning commenced.

Work brought from home may be gingham or calico, kitchen aprons, ruffles to hem and gather, darning and mending.

GRAMMAR SCHOOLS.

Ninth Grade—Five Months.

Narrow hems; hems of medium and broad widths.

Tucks. Threads should not be drawn from the material to secure straight tucking.

Plain fells less than one-eighth of an inch in width. French fells.

Fine gathering, hemmed to a band.

Button-holes commenced.

Shirt or other four-holed buttons sewed on.

Stocking mending and patching.

Shoe-bags, sleeves, aprons, muslin skirts and plain undergarments may be brought from home to be made and kept in school until finished.

Tenth Grade—Five Months.

Bias seams of all kinds.

Gathering, as done on dress skirts, to be over-seamed to a band.

The two stitches used on flannel undergarments, viz: herring-bone stitch and feather stitch.

Button holes.

Children's plain underwear, boys' shirt-waists, collars and cuffs, dusting caps and plain flannel shirts may be supplied from home.

Mending of all kinds must be encouraged by the teacher.

Eleventh and Twelfth Grades and Senior Class.

Questions and review on all work done in previous grades.

Cutting, fitting and making of plain garments.

The work supplied from home may be shirts, undergarments of all kinds, and materials for above.

Miss Charlotte Pendleton, on behalf of the Public Education Association of Philadelphia, strongly urges an addition to the high school for girls, "with such features of manual training and related studies as will make it hold a similar relation to the education of girls as that held by the manual training school to the education of boys." Her argument, in brief, is as follows:

The establishment of the boys' manual training school involved simply the introduction of methods which had already been thoroughly tested, and we are fully sensible of the difficulties to be encountered in formulating household science, and in evolving the principles underlying household economy. The establishment of such a school would involve all the difficulties and all the merits of original work. If successful, it would be, at least, as valuable in the social economy as manual training for boys; would lead to as many lucrative employments, and would be only less creditable to the orginators because the method is not original with them; for the great Russian, who extracted the principles underlying the use of tools, pointed out the manner in which the underlying principles of any group of occupations may be extracted and applied.

The purpose is to secure for women the advantages of the new education from which, as yet, they have been excluded.

In our opinion, the underlying principles of applied household science are better adapted to such a girls' high school than the underlying principles of the use of tools. They bear natural relation to women's usual occupations, developing mental activity and manual dexterity in those subjects which will enter, in one form or another, into the life of every woman. They will intelligently and scientifically approach problems which they have heretofore approached in ignorance, and solved, if at all, by empirical methods. They would lead to openings in avocations and trades without the economic objection of covering exactly the same ground of approach to exactly the same trades as those toward which the manual training for boys is heading. We cannot overestimate the influence upon the home, upon the factory, and upon the school, of sending out into the community a body of women thoroughly trained in the principles of applied household science.

Such a department does not present any serious difficulty. Every school has classes in science which could be readily directed to bear upon the economy of the house, and which, by changing the text book to experimental methods, would be in accordance with the best tendency of the day in education, in classes of applied science and physics, covering economic botany and physiology, hygiene, sanitation and marketing.

The department of manual training should include sewing, cooking, carpentering, molding, architectural and costume designing, illus-

trative particularly of the evolution of the house, weaving, dyeing, etc.

In the high school department proper, book keeping, constitutional history, and history and literature, if given in the new methods, which treat of customs, social life, etc., would bear as directly as household science upon the manual department. Instruction in at least one study of each of these departments should be given each day, so that, as in the boys' manual training, every step is only a development of that which has gone before. The home is no more qualified to give broad mental and manual education in the principles underlying household economy, than the shop is qualified to give instruction in the principles underlying the trades.

The several branches of manual training for girls, which the board have introduced in this city, have led up to this possible solution of the difficult problem of what shall be taught to girls to set women thinking and working intelligently and profitably upon the great problems of household economy, which are as vital to the civic welfare as are the problems for whose solution we are seeking to fit men in the manual training schools.

We trust that it will be given to Philadelphia to institute this great work for her own benefit and honor, and for the advantages of women wherever the system of public education extends. The following is an outline of the

PROPOSED SCHEME OF STUDIES.

1. *Literary Department.*—Ordinary English branches—book-keeping, history (especially the evolution of the house) illustrative of social customs; one language besides English, household economy, composition upon subjects relating to economics.

2. *Scientific Department.*—Household chemistry, physics, especially as bearing upon hygiene and sanitation, namely economic botany, that is the vegetable kingdom as the source of food supply, and wood where it enters into the structure of the house. Physiology as the source of food supply, biology and geology and mathematics in those branches which bear upon economics; experiments in fermentation and action of alkalies, acids, etc., upon tins, etc.

3. *Manual Training Department.*—Drawing, free-hand, mechanical and architectural, designing, modeling and clay-baking, weaving, coloring paper, wood and textile fabrics, dyeing, staining, use of bench tools. For instance, in the applied household science, moths, what is their nature? What do they feed on? Where do they lay their eggs? In what is it present? Examine hair under microscope that has not been properly cured. Cure the hair.

Fermentations show the growth of the plant in grapes, vinegar, beans, canned fruits and vegetables, yeast, etc., experiment in fer-

mentation in these various growths. Extracts and various methods of flavoring, analyze dyes and their effects when poisonous. Examine to this effect the threads in hose, etc., also to detect defective threads, flaws, etc., and to become familiar with the form of the thread. Color, form, texture; color, form, texture; through every year, every session, every day, the eye, the hand, the brain, should be trained in precision and delicacy in dealing with these phenomena of matter. By design, free-hand and mechanical, to be carried out in wood and based upon mineral or vegetable forms revealed by the microscope, and carried out in form and color, in woven textile fabrics. Texture and form by spinning, weaving, including modeling and costuming. Color by staining and dyeing, each in its various stages. Will there ever be good supply until there is educated demand?

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8. PITTSBURGH, PA.

Pittsburgh Cooking School, or "School Kitchen."

Mr. Charles Reisfar, Jr., secretary of the central board of education, Pittsburgh, kindly furnishes the following statement:

November 15, 1888.

"The Pittsburgh school kitchen was opened February 27, 1888. Since this time two hundred and twenty-five (225) pupils have taken the prescribed course of study.

"A copy of the enclosed blank was sent to the parents of the pupils attending school in order to ascertain their opinion as to the merits of the school kitchen.

"We have received about two hundred answers, all favorable to the school."

The following is a copy of the blank sent out:

OFFICE OF CITY SUPERINTENDENT,
June 15, 1888.

In order to ascertain the opinion of parents on the merits of the school kitchen as an educational agency, we would respectfully request you to fill the following blanks, and also to make any other observations that you may deem of value.

GEO. J. LUCKEY.

1. Has the instruction received at the kitchen school been of value to your girl?

2. Has her attendance at the kitchen increased her interest in, and love for, home work?

3. Has her attendance at the school kitchen in any way interfered with her progress in other studies?

The commission was permitted to examine the original answers to

this circular. The answer to the first two questions were in every case affirmative, and to the second, negative, the negative being slightly qualified in two or three instances, as "not materially," "I think not," or a similar guarded expression.

The value of the answer is greatly increased by this indication of deliberate carefulness on the part of the writers, and some of the accompanying "remarks" are so interesting, as testimony directly out of the home and exhibiting the observed influence there of the school room work, that extracts are here given:

"The school kitchen is but one step in the order of making our education more practical."

"The school kitchen is a move in the right direction, and is calculated to be of great benefit to all classes, and especially to the middle class; no lady's education is complete unless she has a thorough knowledge of household duties, the principal feature of which is to be able to cook properly and economically. We hope the school kitchen will be continued."

"I consider a course of lessons at the school kitchen to be desirable for any girl, and candidly admit that I have gained some ideas myself from my little daughter's instruction."

"I was greatly surprised and also very much pleased to see how well my girl learned to cook so many useful things; as I would not have taken the time (nor patience) to teach one so young, and I think the cooking school is a great success."

"My little girl took little or no interest in kitchen work before her instructions in school kitchen, but since her first lesson she has been trying to cook, bake, etc., with more or less success, and is only too sorry that one more lesson is all that under the present arrangement she shall receive. I think that the educators of our community would confer a great favor on our rising generation if they would increase and foster school kitchen instruction."

"I am happy to congratulate you on the success of the school kitchen. I am very much pleased with the progress of the pupils made in general, and particular with my little daughter. In addition I favor the industrial school for girls to learn sewing and fine needle work (if not needed in future as a source to make a living), they would learn how work of that kind should be done, and if done correctly."

"Two or three hours a week would not materially interfere with other studies, it would rather be a source of recreation for the children in my opinion."

"My *girl* is a *boy*. I think if the cooking school makes the girls as anxious to prove that they can cook, as it has my boy, and if they do as well as he does, I think it is a decided success, he has practiced at home on quite a number of his lessons.

"Don't think it has interfered with his regular lessons."

"We are ready to vote the school kitchen a success. From observation (in the case of my daughter), I find, that cooking taught at home comes to the child in the nature of a task more or less disagreeable, and precludes to a great extent the success desired. At the school kitchen it presents itself in the more agreeable form of pleasant experiment, exciting enthusiasm, which in itself is a guarantee of success."

"My daughter has cooked—at home—almost all the dishes in her course of study, with much success; they being palatable and nice in appearance. None of her cooking has gone to the waste barrel."

"I am satisfied from personal observations (in the case of my girl), that she has taken greater interest in the cooking department at home than ever before, and it seems to be a pleasure to her to go about her duties (probably owing to the splendid system she has been taught), what would otherwise have had the effect of proving burdensome."

"I cheerfully endorse the system of home work as taught in the school kitchen."

"I think the school kitchen as an educational agency is or may be productive of great good."

"No dyspeptic can be a Christian."

"Dyspepsia is caused, in a great measure, by poor cooking. The school kitchen should improve the cooking, annihilate dyspepsia and increase Christianity."

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9. TOLEDO, OHIO.

Manual Training School—Economy Department.

The course of study and training for girls is as follows:

FIRST YEAR.

Senior Grammar School—(1) *Mathematics.*—Arithmetic.
(2) *Science.*—Physical Geography.
(3) *Language.*—Grammar, Spelling, Writing, English Composition.
Manual Training School—(4) *Drawing.*—Free-hand and Mechanical, Lettering.
(5) *Domestic Economy.*—Light Carpentry, Wood Carving, Care and use of tools.

SECOND YEAR.

Junior High School—(1) *Mathematics.*—Algebra, Arithmetic.
(2) *Science.*—Physiology and Botany.
(3) *Language.*—Grammar, Rhetoric, Writing.
Manual Training School—(4) *Drawing.*—Free-hand and Mechanical. Designs for Wood Carving.
(5) *Domestic Economy.*—Clay Modeling, Wood Turning, Introduction to course in Cooking or Garment Cutting and Making.

THIRD YEAR.

Middle High School—(1) *Mathematics.*—Geometry, Arithmetic Reviewed.
(2) *Science.*—Physics.
(3) *Language.*—English, Composition, History.
Manual Training School—(4) *Drawing.*—Free-hand and Architectural, Designing from Plant and Leaf Forms.
(5) *Domestic Economy.*—Instruction in Preparing and Cooking Food, Purchasing Household Supplies, Care of the Sick, etc.

FOURTH YEAR.

Senior High School—(1) *Mathematics.*—Plane Trigonometry, Mechanics.
(2) *Science.*—Chemistry, Book-keeping, Ethics, Rights and Duties, Laws of Right Conduct.
(3) *Language.*—Political Economy, English Literature and Composition.
Manual Training School—(4) *Drawing.*—Machine and Architectural Details, Decorative Designing.
(5) *Domestic Economy.*—Cutting, Making and Fitting of Garments, Household Decorations, Typewriting, etc.

"The above course in domestic economy is arranged with special reference to giving young women such a liberal and practical education as will inspire them with a belief in the dignity and nobleness of an earnest womanhood, and incite them to a faithful performance of the every-day duties of life; it is based upon the assumption that a pleasant home is an essential element of broad culture, and one of the surest safeguards of morality and virtue.

"The design of this course is to furnish thorough instructions in applied housekeeping, and the sciences relating thereto, and students will receive practical drill in all branches of housework; in the purchase and care of family supplies, and in general household management; but will not be expected to perform more labor than is actually necessary for the desired instruction."

In cookery practical instructions will be given in the means employed in *boiling*, *broiling*, *baking*, *frying* and *mixing*, as follows;

Boiling.—Practical illustrations of boiling and steaming, and treatment of vegetables, meats, fish and cereals, soup-making etc.

Broiling.—Lessons and practice in meat, chicken, fish, oysters, etc.

Breadmaking.—Chemical and mechanical action of materials used. Manipulations in breadmaking in its various departments. Yeasts and their substitutes.

Baking.—Heat in its action on different materials in the process of baking. Practical experiments in baking bread, pastry, puddings, cake, meats, fish, etc.

Frying.—Chemical and mechanical principles involved and illustrated in the frying of vegetables, meats, fish, oysters, etc.

Mixing.—The art of making combinations, as in soups, salads, puddings, pies, cakes, sauces, dressings, flavorings, condiments, etc.

Marketing and Economy, etc.—The selection and purchase of household supplies. General instructions in systemizing and economizing household work and expenses. The anatomy of animals used as food, and how to choose and use the several parts. Lessons on the qualities of water and steam; the construction of stoves and ranges; the properties of different fuels.

The textile fabric work will cover instructions in garment cutting and making; the economical and tasteful use of materials, millinery, etc.

The second annual report of the school for 1886 says:

"The department of domestic economy has been received with great favor and support and promises to meet the full expectations of those who most warmly encouraged its establishment. The instruction in cookery has proved of great practical value."

APPENDIX II.

TECHNICAL EDUCATION IN SOME FOREIGN COUNTRIES.

1. FRANCE.

The system of public education in France, like every other branch of the public service, is highly centralized, and is so closely interwoven with the administrative organization of the Republic that the former can scarcely be understood unless the latter is also kept in mind.

For purposes of administration, France is divided into 87 departments; these departments are subdivided into 362 "arrondissements," 2,865 "cantons," and about 36,000 "communes."

Each department is administered by a prefect appointed by the President of the republic, and each arrondissement by a sub-prefect; the prefects being divided into three classes, according to the importance of the department.

The authority of the prefect is great in his own department; he can issue local decrees; he appoints and dismisses a number of agents who depend directly on him; he is at the head of the police to maintain public order, and for this purpose can summon the military forces; he superintends the collection of taxes; he is in correspondence with all the subordinate functionaries in his department, to whom he transmits the orders and instructions of the ministers; in one word, he is the general agent of Government, and the principal instrument of centralization in the State. He is assisted in his work by two bodies, the general council (*conseil général*), which is elected by universal suffrage, and the council of prefecture, which is nominated by the head of the executive power. The business of the council of prefecture is to decide all legal questions and to advise the prefect, when asked to do so. The general councils assess the taxes, authorize the purchase, sale, or exchange of departmental property, superintend the management of the same, decide about new roads, railways, or canals, vote the budget for sanitary and charitable institutions belonging to the department, and give advice on every matter of local interest, political questions being strictly excluded.

As the prefect in the department, so the sub-prefect, with a more limited authority, is the representative of the central power in the arrondissement. He is assisted, and to a certain extent controlled, in his work by the council of arrondissement—an elective body to which each canton of the arrondissement sends one member. Except in that case, the canton is not an administrative division.

The commune is the administrative unit in France. At its head is a mayor assisted by deputy mayors (*adjoints*), the number of whom varies according to the poulation; communes of 2,500 inhabitants have one deputy-mayor; up to 10,000 inhabitants they have two, from 10,000 to 30.000 three, and one additional for every 20,000. The mayor has a double part to perform, as he represents both the central power and the commune; and often it is a difficult matter to avoid a conflict of duties. He is besides *officier de l'état civil*, or official registrar of births, marriages, and deaths. The mayor and the deputy-mayor are not salaried officials. In the large towns they are nominated by Government, but they must always be chosen out of the municipal council, which is elected on the principle of universal suffrage, and has with regard to the commune much the same power and duties as the general council with regard to the department.

Educational Organization.

Upon this system the above statement of which is borrowed almost literally from the Encyclopædia Brittanica, is based the organization of the Service for Public Education.*

From the University point of view, the territory of France is divided into seventeen *académies*. Each *academie* has a rector at its head, who, under the authority of the Minister of Public Instruction, is charged with the material administration of higher and secondary education, and with the methods of primary instruction in his district. The administration of this last belongs to the prefect of each department, assisted by an *academy* inspector. In each of these three successive stages—department, *academy* and central administration—is placed a council, possessing administrative and disciplinary powers.

The *Departmental Council of Public Instruction*, which comprises six officials, four councillors-general (elected by their colleagues), two schoolmasters, and two schoolmistresses for public primary education (elected by their colleagues), and, in certain cases, masters of private schools elected in like manner, forms a disciplinary council for primary education, either public or free (*i. e.*, State or private). This council sees to the application of the programmes, lays down rules, and appoints one or more delegates in each canton to superintend primary schools.

The *Academic Council*, which comprises officials, members elected by the professors of secondary and higher education, and members appointed by the Minister, performs similar functions with regard to secondary and higher education.

The *Higher Council of Public Instruction* sits at Paris. It comprises forty-four elected representatives of the three educational orders, nine university officials, and four "free" schoolmasters appointed

*This account is taken from the recent and valuable work of MM. Lebon and Pelet. "France as it is."

by the Minister, and is the disciplinary court of appeal for the two preceding councils. The Minister is, moreover, obliged to consult it in all questions of programmes, methods, rules, etc., without, however, being bound to follow its opinion.

Such is the frame work, administrative as well as judicial, in which education, whether public or free, lives and moves. And now let us see what this education is, beginning with the public schools.

The Different Degrees of Education.

Since 1882 *Primary Education* has been compulsory for all children of both sexes, from the age of six to the end of the thirteenth year, unless before reaching the latter age they have been able to pass an examination, and to gain the certificate of primary studies. To satisfy the law, the child's name must be entered at a public or private school; he may, however, continue to receive instruction at home, but in this case, after he has reached the age of eight, he must be examined every year before a State board, and if the examination is judged insufficient the parents may be compelled to send him to a public or private school. At the age of thirteen the child is set free from further teaching, whatever may be the results of the education he has received. The law's sanction lies in the right which a municipal school committee possesses of ordering the names of parents in default to be posted on the door of the town-hall. If the offense is repeated the parents are liable to a fine of from one to fifteen francs, and to a term of imprisonment varying from one to five days, both which punishments have to be ordered by the *Juge de Paix.*

In public schools the course of instruction does not include, as we have said, religious teaching; but one day in the week the school must take a holliday, to allow parents to provide such teaching for their children if they wish to do so. The school building cannot be used for that purpose. In private schools religious instruction may be given, but this is optional.

The programme of primary education includes: Moral and civic instruction, reading, writing, French, geography and history (particularly those of France), general notions of law and science, the elements of drawing, modeling and music, and gymnastics.

No person of either sex can become a teacher, either public or private, unless he possesses the "certificate of capacity for primary instruction" given by a State board. For the future, putting aside certain temporary arrangements, no member of a religious community will be eligible for the post of master in a public school. Private schools may be opened anywhere as long as a suitable building is chosen, and the State supervises them from the point of view of public morality alone.

The public schoolmaster is a State official, appointed by the pre,

fect, and is entitled to a retiring pension. In principle, it is true public primary education has to be provided by the communes; it is, however, showing a marked tendency to lose this original characteristic and to become a charge upon the State. The State, in fact, began by laying certain obligations on the communes; afterwards, when education was made compulsory, it was made gratuitous to all children without exception; this caused a considerable loss to the communes, and the State came to their help with regular grants. This help was repeated when the communes were obliged to burden themselves with the cost of new school buildings, necessitated by the increase of the school-going population. Finally, from the point of view of the school courses, primary education, like the other grades of education, is centralized by the State.

As a general rule, every commune is compelled to maintain a public school, and if it has more than five hundred inhabitants, a second school for girls only. It may also have, if it pleases, schools for little children (*ecoles maternelles*) or infant schools, for children under six; supplementary evening classes for children over thirteen; higher grade primary schools where more advanced instruction can be had, etc.; but its strict obligations are limited to the primary school, properly so-called. The department must provide a normal school for masters and a similar institution for mistresses, where they can be trained. The State, finally, has two training schools for the higher grade primary teaching at Fontenay and St. Cloud, near Paris, where masters are prepared for the departmental training schools. The result of all this is, that the sum total of the State's expenses for primary education in 1887 is as high as eighty-five million frânces ($17,000,000) and that without mentioning grants for school buildings, whereas in 1887 the sum total was only twelve million ($2,400,000.)

This considerable effort, which may even appear excessive when we consider the short space of time in which it has been accomplished, has not been fruitless. The following figures will give some idea of what has been done. From 1877 to 1886, the number of public schools rose from 61,000 to 66,500; that of the pupils from 4,200,000 to 4,500,000*, with 96,600 masters and mistresses†; that of training schools for male teachers from 79 to 89, of training schools for female teachers from 18 to 77, with 5,400 pupils (3,500 of them women), and 1,200 masters. As to the results a single fact will suffice. In these ten years, before the generations newly called to military service have been able to profit fully by the new state of things, the proportion of illiterate recruits (which is annually made out directly after the lots are drawn) has already fallen from 15 to 11 per cent.

*There are moreover 560 higher grade primary schools with 30,000 pupils.

†In this total the number of members of religious communities has fallen from 37,000 to 16,400, of whom 14,000 are women; the remaining members of communities are all provided with the necessary certificates of capacity, "lettres d'obedience" being no longer recognized.

As to private primary education, the latest official figures are for the scholastic year 1885–1886. At that time it had 13,255 schools, of which 3,991 were lay, and 9,264 under the control of members of religious communities, with 321,000 boys and 751,000 girls.

At the present moment it is reckoned that twenty per cent. of children of the scholastic age are in private schools, and that of these 17 per cent. are in schools directed by members of religious communities. The public schools taught by members of religious communities are still tolerably numerous, these communities thus supplying the education of a total of 32 per cent of the children of France.*

Secondary Education, according to the official programmes, is divided into classical education (literary or scientific) and special. These three branches of education include some subjects common to them all, such as French, history, geography, etc., while others are special to each of them, or more developed in one branch than another. Latin and Greek form the principle basis of the literary education, along with philosophy and the elements of mathematics and natural science. The study of the sciences goes deeper in the scientific classical education. while that of the dead languages and philosophy is very limited. In each course the pupils have to learn one modern language (English, German, Spanish or Italian), while in the special education two modern languages are necessary, and also some knowledge of law and political economy. The duration of this education is from nine to ten years. Speaking broadly, and apart from its purpose of cultivating the mind generally, the classical education prepares for the higher studies which lead to the legal career, to the teaching of literature, to historical studies, etc., or (when it is scientific), to medicine and to the different professional State schools. The special education is reserved for youths destined to commerce or manufactures.

At the present moment the State provides secondary education in 98 lycées and 256 colleges distributed over the country. The lycées differ from colleges in the fact that the former are principally paid for by the State, while the communes bear the greater part of the expenses of the latter. Professors in lycées are of higher rank and superior capacity to those in colleges, and among the colleges those which are called second-class do not give the complete secondary education. In both lycées and colleges the programmes are the same, drawn up by the central authority and controlled by the State Inspectors, the expenses of the State for secondary education being thirteen and one-half million francs ($2,700,000). The professors are appointed by the State, and have to be provided with certain certificates of capacity; there were 3,143 professors in the lycées in 1886.

Of the above sum, however, one and a half million francs ($300,-

*In 1885–1886 there were still 6,667 communes having educational courses for adults with 168,000 men pupils, and 1,135 with 30,000 women pupils.

000), is devoted to the thirty-five lycées and colleges for the *secondary education of girls.* The creation of these establishments, attempted for the first time in 1880, was intended to divert a certain number of girls from the convents and private schools where they used to be taught, in order to give them an education which should conform in its general spirit—with the modifications made necessary by the difference of sex—to the education given to boys. There are still a considerable number of towns where neither lycées nor colleges for girls have been started, and in these classes for secondary instruction have been organized for young ladies, and are held by the professors of the boys' schools. The results of this enterprise have been hitherto satisfactory, but it is still in its infancy.

Secondary education is not, of course, compulsory, but neither is it gratuitous. Two remarks are, however, necessary on this last point. On the one hand it is the custom to offer a certain number of scholarships every year for competition among the poorest and cleverest children, the successful ones receiving their education and sometimes their board and lodging free in the State* establishments; on the other hand, the price of board is very low for the paying pupils, and it may be said that, as far as that goes, the State renders competition very difficult to private initiative. The State not only gives its pupils education strictly so-called, but boards and lodges about half of them at an extremely low rate. The tuition fees vary from $12.00 to $80.00 a year, according to the age of the pupil and the town he lives in. Board and lodging cost from $110.00 to $260.00 a year. The system of boarding scholars has often been attacked on moral and sanitary† grounds; it maintains its position, however, because it is democratic in the sense that it enables parents living at a distance from towns supplied with lycées and colleges to send their children to them. It has even been extended to the girls' colleges recently established. Most of the lycées receive both boarders and day-scholars, sometimes boarders only.

In 1886 the number of pupils in schools for public secondary education was estimated at about 100,000—an increase of 20,000 on 1876—of whom 9,600 were girls, giving an average of 263 scholars per school. The exact figures for the scholastic year 1883–4 were as follows:

*In 1887 the State was paying over three million francs ($600,000) in scholarships, without counting what the departments and the communes on their side often do. In 1883–1884 there were 4,662 holders of scholarships in secondary education; to-day there are 2,000 in the higher grade primary schools, and some hundreds in the schools for higher education.

†The chief charge brought against the boarding-school system from the sanitary point of view is that the children are not allowed sufficient time and space for physical exercise.

	No. of schools.	Total No. of pupils.	Boarders.	Day scholars.	Exhibitioners.
Lycées for boys, . . .	97	49,442	24,990	24,452	4,662
Colleges for boys, . . .	257	41,000	16,212	24,788	1,919
Lycées for girls, ...	10	1,281	197	1,084	. . . . .
Colleges for girls, . . .	13	1,656	405	1,251	. . . . .

As regards the nature of the education given, the pupils were thus divided in 1886:

	Primary education.	Secondary, classical or scientific education.	Special education.	Secondary education for girls.
Boys' lycées, ...	6,020	33,309	10,113	. . . .
Boys' colleges, . . .	9,213	18,139	13,647	. . . . . .
Girls' lycées, ...	464	. . . . . .	. . . .	817
Girls' colleges, . . .	869	. . . . .	. . . .	787
Totals, ...	16,566	51,438	23,760	1,604

Free secondary schools may be opened subject to the production of certain certificates of capacity on the part of the director alone; the State then supervises the working from the point of view of public morality. It is calculated that the free Catholic institutions have about 48,000 pupils, with an average of 143 per establishment. The part taken by lay schools of the above character is inconsiderable.

But an incomplete idea of the social importance of secondary education in France would be conveyed to the reader were the important part played by the baccalaureate ignored. The baccalaureate is an examination which young men have to undergo at the end of their studies. It is not conducted, as in Germany, by a board of examiners chosen from the professors of the institution where the boy has been educated, but by professors of faculties—an arrangement which gives it a peculiar solemnity. The bachelor's diploma, given to candidates who have successfully passed through the written and *viva voce* tests of the examination, is not a simple certificate of studies, but a university degree, of inferior rank it is true, but which is indispensable for attendance at the courses of the higher education and for admittance to certain schools. Even where the production of this diploma is not compulsory its possession gives a formidable advantage in the various competitions in which its holders may be called on to take part. Hence arises a widely spread ambition among the middle classes to possess this diploma, and, unfortunately, many young men after obtaining it imagine themselves very learned, too learned even to embark upon commercial or industrial careers, which they think themselves entitled to qualify as vulgar.

Till lately there have been three sorts of baccalaureate; the baccalaureat-es-lettres, which involves two examinations with a year's interval between; the complete baccalaureat-es-sciences, and the limited baccalaureat-es-sciences, this last named being more especially devoted to the natural sciences. The first is required for the study of law, the second or third for that of medicine, for instance. In 1883 out of 16,124 candidates for the different baccalaureates, 3,597 obtained the diploma for literature, 2,628 the "complete" science diploma, and 552 the "limited" science diploma; the proportion of failures for each category respectively was 53.4*, 62.9 and 58.9 per cent. Of late efforts have been made to divert a portion of the French youth from the baccalaureate, and thus to avoid the overcrowding which results from it in the so-called liberal professions, to the disadvantage of trade and manufactures. With this object an attempt has been made to develop special secondary education; unfortunately a fourth baccalaureate was devised to serve as its end and recompense, and, this baccalaureate once created, the obligation was felt and acted upon of insuring it certain rights at the entrance of those very careers where there are too many young men already. It is a question which is occupying many minds in France at the present day, but which has not yet been determined in a satisfactory manner.

The recent progress of the country in this direction, is thus summed up by M. Jules Simon:†

> Within the last twenty-five years the system of primary instruction has undergone a complete transformation; instruction has been rendered obligatory; superior primary schools have been founded in every direction; each department has either alone or in common with a neighboring department its normal school for male teachers, and another for female teachers; liberty of higher education has been proclaimed; secondary education for girls has been established; a large system of appropriations has brought the highest grades of education within reach of all. Books, collections, apparatus of study and of work have been increased in vast proportions. At the same time the revenues have been considerably increased. France, which had lagged behind most civilized nations, has resumed its place among the first. Probably no other nation at the present time is giving more attention to these schools or expending more money for their support. This progress has not been achieved without opposition, and even in its present condition the system is not without its enemies.

Manual and Technical Training.

But France has not been content with creating a system of general education, comprehensive as we have just seen it to be. She has devoted no less of zeal and intelligence to the establishment throughout the country of special technical instruction, either in connection with the public schools or in separate institutions. She has not only set herself to educate her people, but she has especially set herself to adapt that education to the needs of the present industrial era. Ever

* At the first examination for the baccalaureat-es-lettres the proportion is 59.5 per cent.; those who fail cannot present themselves for the second examination.

†Condensed from Simon's "*L'Ecole.*"

since the establishment of the present republic, and especially since 1878, many of the ablest minds in France have diligently occupied themselves with the question how best to broaden the basis of general knowledge and, at the same time, introduce into the schools a kind of training best adapted to prepare youth to become intelligent workers in industrial pursuits. This practical aim has dominated every step. When the bill for the establishment of schools of manual apprenticeship (afterwards known as the law of December 11, 1880) was before the Senate, M. Tolain, the reporter of the bill and one of its most earnest advocates, said, "The value of the workman's labor in France is diminishing, because the intellectual value of the workman himself tends to decline. Machinery more and more takes the place of the workman. Such workmen as are still employed are more and more specialized and restricted to minute processes which are no longer a trade, but a fragment of a trade. There are continually fewer artizans and more hand-workers. The remedy is, to give to the children of workmen an education capable of awakening in them the feelings which formerly prevailed among artizans; first, to develop their intelligence and then to increase their technical knowledge, so that they may be able, at need, to pass from one industrial specialty to another, to understand their trade as a whole and in its details, and sometimes even to improve its processes." Following this general view, the organization of the system of manual training has received the most careful consideration. The subject was elaborated as a whole and in all its details by several very able commissions, and so strong a hold has it taken upon the public mind, that many leading statesmen have conspicuously identified themselves with the movement.

Primary instruction is given in four kinds or grades of schools:

1. Maternal schools and infant classes.
2. Elementary primary schools.
3. Higher primary schools, and higher classes in primary schools, called "complementary courses."
4. Manual apprenticeship schools.

In all these schools, some form of manual training is required, under the law of March 28, 1882, and, while it has not yet been found possible to carry out the law fully in all cases, especially in the smaller rural communities, the general scheme has been firmly established and long steps taken towards the universal introduction of it. The scope of the manual exercises will be best understood by an examination of the following programme presented by Senator Tolain's commission in 1881, as a part of the report then made to the minister of public instruction.

PROGRAMME.

INFANT SCHOOL.

(Application and extension of the Fröbel system. Education of the senses.)

PRIMARY SCHOOL.

(Manual exercises intended to develop the children's skill of hand.)

Elementary class (7 and 8 years old).—1 hour per day.

Elementary exercises in freehand drawing, symmetrical arrangement of forms; cutting out pieces of colored paper and applying them upon geometrical forms; exercises in coloring, cutting out geometrical forms in card board; representations of geometrical solids. All these exercises to be done first on squared and subsequently on plain paper.

Small basket work.—Arrangement of strips of colored paper: First, in interwoven forms; second, in plaited patterns.

Modelling. Reproduction of geometric solids and simple objects.

Intermediate class (9 and 10 years old.)—1 hour per day.

Cutting out card-board patterns; construction of regular geometric solids; construction by the pupils of card-board models, covered with colored drawings or colored paper.

Small basket work; combinations of plaits; basket making.

Objects made of wire; trellis or netting; wire chain making.

Combination of wire and wood. Cages.

Modelling simple architectural ornaments.

Object lessons. Principal characteristics of wood and the common metals.

Upper class (11 and 12 years.)—2 hours per day.

Drawing and modelling. Continuation of the exercises in the preceding class. Repetition of the ornaments previously executed, in the form of sketches, with dimensions attached to them. Drawing the requisite sections for this purpose. Reproducing the sections as measured sketches. Study of the various tools used in working wood. Hammer, mallet, chisel, gimlet, centre bit, brace, screw driver, compasses, square, marking guage, saws of different kinds, jack plane, trying plane, smoothing plane, files and rasps, level.

Theoretical and practical lessons on the above.

Planing and sawing wood. Construction of simple joints.

Boxes nailed together, or jointed without tacks.

Wood lathe. Tools used in turning. Turning simple geometrical forms.

Study of the tools used in working iron: Hammer, chisel, cutting tool, cold chisel, squares, compass, files, etc. Theoretical and practical lessons concerning them.

Exercises in filing, smoothing and finishing rough forgings or castings (cubes, polygonal nuts).

The practical work in the shops in primary schools is to be followed by gymnastic exercises, in accordance with a special programme.*

The superior primary school system of France owes its origin to Mr. Guizot, who effected its organization by the law of 1833. The various changes in the law from that time to the present have been made to meet the complex and changing needs of the classes for whose benefit this grade of education was inaugurated. These suc-

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*The programme includes manual work for girls. This is also arranged in three courses and comprises knitting, plain sewing and embroidery, to which are added in the elementary course manual exercises designed to develop dexterity, such as cutting out and fitting pieces of colored paper; first attempts at modelling. In the superior course, instruction is given in the elements of pomestic economy, with practical applications to the kitchen, laundry, the house generally, the garden and yard; practical instruction is given in the school and at home.

cessive changes in the law have led to corresponding alterations in the programmes promulgated from time to time; and it is proper to regard the accompanying programme as a tentative rather than a final and permanent expression of the character of the education it is intended to give in this class of schools.

SUPERIOR PRIMARY SCHOOL.

The superior primary instruction given in the school will comprise the subjects specified in the following programme, as fixed by the ministerial decree of January 15, 1881, for schools having a course extending over three years and more.

Morals.—The principles of morals. Duties and rights of the citizen. Elementary principles of political economy.

French language.—Methodical study of grammar and orthography. Etymology and derivation of words. Reading with proper emphasis and explanation of the meaning. Exercises in style and composition. Elements of the history of literature.

Writing.—Principles and practice of running hand, round hand, and commercial handwriting.

History.—Principal characters of antiquity. History of France up to the present day. Development of national institutions. Chief epochs of general history (ancient history, middle ages, and modern history).

Geography.—Physical and political geography of the five quarters of the world. Special study of the geography of France, comprising the divisions for administrative purposes. Economic geography. Map drawing.

Modern languages.—One modern language at least.

Mathematics.—First year: Theoretical and practical arithmetic; first elements of ordinary geometry. Second year: Advanced arithmetic; elements of algebra; plane geometry and its applications. Third and fourth years: principles of algebra as applied to the solution of simple equations; the elementary principles of rectilinear trigonometry as applied to the estimation of triangles; elementary principles of solid geometry and their application; the common curves.

Accounts.—First principles of commerce and account keeping; book-keeping; current accounts bearing interest.

Physics.—The most important phenomena and the chief theories of physics. Modern discoveries and the applications of science to daily life.

Chemistry.—Exercises involving the observation and examination of some of the familiar facts introductory to the study of chemistry. The metalloids and the most useful metals. The laws of chemistry. The elements of organic chemistry.

Natural history—Organs and functions of men and animals. Practical study of the principle groups of animals and vegetables. Application of hygiene to the local industries. Principal facts of geology and examination of the best known minerals.

Drawing.—Geometrical drawing. Lines, plane surfaces, elements of tinting. Solids. Obtaining the points of intersection in penetrations of solids and projections. Principles of perspective. Figured sketches. Essential parts of machinery and plans of buildings. Drawing from relief models and from the cast.

Singing.—Choirs with three parts.

Gymnastics.—Exercises in which all do alike. Exercises with apparatus. Military exercises.

NOTE.—The subjects in this programme are to be apportioned over the three years' course so as to apply in the best way to the requirements of the professional instruction.

PROFESSIONAL INSTRUCTION.

First year (2 hours per day).—Supplement to the superior primary classes.

Drawing and modelling. Execution of the regular geometric solids of given dimensions from figured sketches.

Workshop teaching:

First period.—Working in wood. A box. A drawing board. A mortise and tenon joint. An oblique joint. A slit and tongue joint. A joint halved together obliquely. A St. Andrew's cross. Various kinds of scarfed joints.

Second period.—Working in iron. Exercises with the file on an uneven piece of iron. Make rectangular parallelopiped, with a square base of given dimensions. This is to be converted into an octagonal prism; then into one with sixteen sides. This to be filed round. Then, in the lathe, to turn this into a cylinder of specified diameter, and finally to convert it into a hexagonal prism.

Third period.—Working in wood. Various kinds of dovetail joints. Splices. Skew splices, halved together (two kinds). Scarfs halved with dovetail pieces.

Fourth period.—Working in iron. Tool making. Two rules in iron of given dimensions. Two plain squares. A pair of callipers. Exercises with the lathe and the cutting chisel.

Second year.—Supplement to the superior primary classes.

Drawing and modelling. Execution of a graduated series of ornamental casts composed of elements of solid geometry, arranged systematically; rosettes, etc.

Work in the shops (8 hours per day):

First period.—Working in wood. Mortise and tenon to molded work. Tenon for miter joint. Mortise and tenon with chamfered dovetail. Tongued joint with cross ties. Mortise and tenon for quoins.

Second period.—Working in iron. An angle out of square. A pair of pointed compasses. A hand vise.

Third period.—Working in wood. Angle open mortise joint. Slit and tongue joint in two thicknesses of stuff. Stepped mortise and tenon. Square joint of two cylinders. Oblique joint of two cylinders. A pair of screw clamps.

Fourth period.—Working in iron. Bit pinchers. Screw wrench. Exercise with the lathe. Exercise with the cold chisel.

Third year.—Supplement to the superior primary classes.

Drawing and modelling. Elements of architecture. Orders and styles.

Ornaments of the different orders and styles.

Industrial drawing. Theoretical principles of composition and of the arrangement of colors.

General principles of the application of drawing to pottery, to fret cutting in wood and metal, to artistic locksmiths' work, and to the ornamental stamping of paper and fabrics.

Chemistry.—Experiments in the laboratory. Manipulation. Analyses. Mode of fixing colors (applied to pottery, stuffs, etc.).

Accounts—Industrial account keeping. Fixing of a scale of profits. Applying the same to the work of tools and simple machines.

Work in the shops (5 hours per day during the first six months, and 7 hours daily during the last six months):

First period.—Working in wood. The making of tools. Molding block. Miter block. Wood bench clamp. Tenon saw. Small hand saw. Inlaying saw. A plane. Use of the wood lathe.

Second period.—Working in iron. The making of tools. A pair of steel squares, one of them to be a rim square. A tap wrench. Working with the cutting chisel.

Third period.—Working in wood. The making of tools. A plane, jack plane, square, marking gauge, grooving plane. Work with the lathe. Model making.

Fourth period.—Working in iron. Making a shifting gauge. Working at the forge. Elementary work. Making of tools, chisels, cross cut chisels, boring bits, etc. Working at the lathe and with the cutting chisel.

Supplementary work in the shops:

After the end of the third year's course the pupils may, if they request it, be maintained at the establishment to work all day long in the shops throughout the holidays.

They will be paid wages for this work.

It will be understood, of course, that in the primary schools this programme is interwoven with the studies of the usual course, which

are not here given. For the superior primary school, both the literary and the professional courses are given.

The course of this movement for the introduction of manual training into the schools, including the protracted and many-sided discussions of means and methods, forms an extremely interesting and important chapter in the history of educational progress; but we must here content ourselves with a limited selection of such documents and statements as will most fully indicate the views of its leading promoters, and the successive steps by which they advanced to the attainment of their end.

When the restored Republic of 1870 came into power there was already in existence an extensive and magnificent provision for nearly every branch of higher education, university and collegiate. Some provision had also been made for primary instruction, more or less under the legal authority of the Government, but mainly under the actual control of the clergy. The statesmen of the new *regimé* vigorously took in hand the work of establishing a system of public schools, which should be freely open to children of all classes and conditions of society, free from clerical control, under the close direction and supervision of public officials, and wholly supported by public funds appropriated by the Nation, the Department or the Commune.

The impulse in this direction did not, however, arise wholly from a sense of the importance of general education in a Republic. The Paris Exposition of 1878, was a revelation to the French people. They saw clearly from an examination of the exhibits made by other industrial nations that, if they were not to fall behind in the march of modern industry, they must infuse more of the modern spirit into their public schools. Since that time, and at equal pace with the growth of the general system, the apparatus for scientific and industrial education has been very greatly increased, and the extensive introduction of manual training into all grades of public instruction has been promoted as a means to the same end. It should be observed, however, and it will appear in the documents cited further on, that the aim of the whole movement has been economic and industrial even more than pedagogical. The problem has been, as stated to themselves by the leaders of French thought, how to train the youth of the country in such a way that all the powers, physical, intellectual and moral, of each child when he came to take his place in the ranks of active society, could be used with the highest efficiency. More narrowly still, the school was to prepare the road to the workshop; and that, both by bringing the work-shop and its methods into the school and by carrying the school, with its principles, its methods, its intellectual habits forward into the workshop.

As to the needs of the situation there was little if any difference of opinion, and as to the remedy, hardly more. The chief point in ques-

tion was, whether manual training as a means of education should become an integral part of the existing system, or be established under a separate system, financial and administrative. The former view prevailed. On the 6th day of March, 1880, a very strong and important commission was appointed, with M. Corbon as president, to consider the whole subject. The commission divided itself into two sections, one under the chairmanship of Senator Corbon, and the other under that of Senator Tolain. These reports present so clearly the considerations which influenced the subsequent legislation on the subject, that we cannot do better than to present them entire.

The report made by Senator Corbon, is as follows :

"*Report to the Prefect of the Seine respecting manual exercises in the primary schools, considered as the Complement of Education, by A. Corbon, Senator, reporter of the Commission appointed to examine the double question of the workshop in the school and the school in the workshop.*"

Monsieur, the Préfet, you appointed, March 6, 1880, a commission for the investigation of two correlative questions of the highest interest and the solution of which might well mark a happy revolution in the method of developing the moral, intellectual and physical force of the youthful generation. One of these questions is to ascertain whether it is necessary and in what measure it would be possible to organize the workshop in the primary school. The other is to know how the school can be continued in the workshop during the course of apprenticeship.

The commission met a few days after its appointment and began its work. It has devoted many sittings to the examination and discussion of the two-fold question presented to it, and has unanimously agreed : (1) that it would be well to attach a workshop to every primary school, in order that the pupils might there obtain manual training; (2) that there is room and need for the creation of apprenticeship schools, upon the plans of that already existing in Paris on the Boulevard de La Vilette. (Ecole Diderot). After reaching this conclusion, the commission resolved itself into two parts, each to consider and report separately upon one of the questions proposed. The present report relates to primary schools.

The full commission considered, at the out set, whether the introduction of manual training into the primary school ought to be regarded as a first grade of professional instruction, or as the necessary completion of a rational education. It declared itself strongly in favor of this second view. It understood that the practical teaching of various trades in the primary school would be almost imposible. In order to give such instruction workshops would be required adapted to all, or at least to the principal industrial pursuits carried on in a city, which would require a plant three or four times larger than that occupied by the largest of our present school establishments. This consideration would not be absolutely conclusive if children, on leaving the primary school at twelve or thirteen years of age, after learning more or less fully the elements of a trade, could find employment in industrial establishments as workmen, or novitiate workmen, but their youth and their physical weakness would, in most cases, prevent this. They would inevitably be reduced to the ordinary condition of apprentices, employed in discouraging tasks for one and even two years ; that is to say, long enough to lose the better part of what they had learned at school. No account would be taken of their professional preparation except in establishments where the chief was exceptionally well disposed ; and it is not wise to base a calculation upon exceptions.

The teaching of trades in the primary school would not be really profitable to the pupils unless they could remain there until the age when they were sufficiently developed physically and prepared professionally to enter at once as workmen into the shops. But it would be necessary to retain them at school three years longer, and for that purpose to quadruple, and even quintuple the extent of the school buildings. It is much more simple and more rational to create establishments of a higher grade

into which boys shall enter on leaving the primary school, and where for three years they will receive a technical instruction at the same time that they complete their elementary knowledge, and from which they will go with force and skill sufficient to enable them to exercise their trade properly. They will thus have escaped the injurious influences undergone by children who are placed in work-shops too early.

These considerations cannot be weakened by the example of what has been done for several years at the primary municipal school de la rue Tournefort. There the pupils are not confined to elementary manual exercises. An attempt is made to give instruction in very different trades, but it can be done only upon a very small and insufficient scale, and, as boys cannot be retained there beyond their thirteenth year, they are neither expert enough nor well enough developed to be employed immediately in workshops outside unless in exceptional cases. Nevertheless the experiment undertaken in this school is extremely interesting. It shows to what degree boys from ten to twelve or thirteen years can exhibit taste and skill in manual exercises without injury to their intellectual work. In fact quite the contrary is true. For this reason, if no other, this school would deserve to be encouraged as a special type.

The question for the commission then is not to determine what it is possible to do in exceptional cases in a primary school, but to ascertain how the system could be made general and enable the pupils of all schools to acquire that complementary education, which is the object of this report. The problem is how to introduce generally into the primary schools those altogether elementary labors which every person ought to be capable of performing whatever his social position; labors which are the foundation of all trades, which serve to develop manual skill, and are in a multitude of cases a means of awakening ingenuity at the same time that they are a precious means of rendering service or of overcoming a difficulty. Moreover these elementary labors require neither a great supply of tools nor extensive room. They can accordingly be taught in all common district (Communaux) schools. The question no longer waits for a theoretical solution. It has been practically solved for several months in a certain number of municipal schools and has immediately given the most satisfactory results. The labors adopted as being most suitable are very simple, carpentry and wood-turning. Later it will be possible, if it should seem desirable, to add working in iron or any other metal. For the present, and professionally, the manual exercises are voluntary on the part of the pupil, and are carried on outside of class hours. Children are not admitted to the shop until after they are ten years of age, and it is worth noting here that those who are of an age to be admitted show the greatest eagerness to attend, and labor with the most remarkable enthusiasm, giving in this way nearly three hours a day to this kind of instruction, beyond the regular class hours, and to the very great satisfaction of their friends. One part of the problem, however, remains to be solved: How could children from six to ten years of age take part in manual exercises without having to use tools for which they would not have strength and with which, besides, they might injure themselves? That is to say, how can the exercises already begun in the infant school be continued in the primary school—certain instructive plays, certain manual exercises well adapted to the natural inclinations of the youngest age? The solution of this interesting part of the problem is at this moment being sought in schools already provided with tools. The pupils old enough to be admitted to the workshop there prepare the materials for instructive plays for their younger fellow pupils.

There will be plenty to do in this direction. The teachers will have to show as much active ingenuity as patient considerateness. They will need specially to abandon the habit of correcting the uneasiness of children by automatic exercises for the whole body. It is a convenience without doubt to have recourse to automatism, but the school is not made for the convenience of the teachers. It is made for the best development of the various faculties of the pupils, and automatic exercises, often repeated, are a complete abandonment of its true aim. The teachers, however, are very generally animated by the most active desire to do well. They will clearly understand and will zealously perform the duties which the new system of education imposes upon them. They will grow in value by the efforts they are forced to make and this will be a clear gain for the youth entrusted to their care.

M. le Préfet: "The task of the reporter is still only half completed. It remains to point out the imperative necessity of making the complementary education, which has just been spoken of, beneficial to the whole body of the youthful generations. If it were merely a question of introducing manual training into the primary school, in order to prepare the children of the people for a life of labor from early youth, one might be content with the foregoing considerations and suggestions, but to work out and apply a system of education exclusively adapted to the children of the people (working classes), which should not be suitable to those of the middle class, would be going in direct opposition to the democratic spirit, and would perpetuate the moral and intellectual separation between these two great social elements. Still further, there is reason to hope that the day will soon come when the primary grade of instruction will no longer be given in the Lycées, and when children of every social condition will be required to begin their education on the benches of the primary school. Not only does the democratic principle require this community of education, but a social interest of the first importance demands it. The mingling of the children of the middle classes with those of the working classes (*peuple*), will have the happiest results. It would be the most important means of nurturing sentiments of good-fellowship among youth of very diverse conditions, and will check at their source those dividing sentiment which have already produced deplorable effects and may produce still more deplorable ones. But aside from the great interest there would be in giving primary instruction in only one kind of schools, and for children of every social position, it should be well borne in mind that the complement of education, which forms the object of this report, and which has been already provided in a certain number of schools, should be made to extend to the whole body of youth. For a long time little attention has been paid in education to the physical being. It was with great difficulty that public opinion secured the introduction of gymnastic exercises. It seemed not to be understood that the intellectual, moral and the physical capacities are closely conjoined in one system, so closely conjoined that if either remained neglected the others were prevented from exhibiting their full force. How, indeed, could the moral forces produce their effects without the aid of intelligence and of the arms? What could the intellect do in a multitude of cases without the aid of the hand? Yet, even to this day, education is conducted as if it were not true that the arm is the indispensable auxiliary of the intellect and the heart; as if the hand, the intellect and the heart were disconnected, and, consequently, as if no attention need be paid to the cultivation of the three orders of faculties. Thence comes a defective education based upon a false principle; a kind of voluntary infirmity which renders so many people incapable of doing anything with their hands. And yet the cultivation of the physical capacities, joined to cultivation of the intelligence and the feelings, has never been so necessary as in our time. The present century is one of prodigious activity, of gigantic labors, of unheard of daring in the field of enterprise, of everything which demands intellectual vigor associated with physical force and manual skill. Moreover, society at the present time is preoccupied with the improvement of education for the new generations in order that they may have in full exercise their moral, physical and intellectual forces. * * * * * * * * *

From a logical point of view the question is clear; from the moment when the solidarity of the three orders of faculty is admitted it is absolutely necessary to provide for their joint development. The natural tendencies of children point in the same direction as clearly as possible. From the time that the child is able to stand, and even before, he wishes to touch everything. He early endeavors to do something with his hands, he desires tools, he wishes to handle them long before he is able to use them; he needs at least a little shovel to work in the earth, a bucket to carry it; he plants imitation trees, he builds and then overthrows his buildings in order to build them again in another way or in another place. In this most people see nothing except the child's way of keeping himself in motion, but such people having eyes see not, and having intelligence, do not understand. They do not see and understand that in these instinctive manifestations of the young being the future worker reveals himself. In truth it is nature that speaks, proclaiming in the child the destiny of the man, and his duty, or at least a part of his duty, in life.

Education should be conformed to this course of nature universally and constantly expressed, or it rests upon false principles.

It is high time to understand the indications furnished by the instinct of children and to give as soon as possible satisfaction to their two-fold need of working with the hands and of knowing the reason of things, that is to say, it is time to bring about a veritable revolution in the manner of raising youth. If one wishes to follow resolutely the course of nature and the clear indications furnished by the instinctive dispositions of children, if manual exercises are considered as essential, they should have a serious part in education commensurate with their importance. In the end it will be found that it is possible to shorten the time of class work in order to give a sufficient amount of time to manual exercises, and that this will be done not only without injury to the intellectual development, but that on the contrary it will promote it. In the first place manual exercises are not carried on without awakening the intelligence, and still further, it is doing violence to the active nature of the children to confine them three hours in succession, twice a day, before the school desk. They submit, but with reluctance; they are subject to constraint; they are ill at ease physically and morally. They would certainly learn better in two hours if the third were given to manual exercises. It should be observed also, in order to obtain more time for the exercises of the workshop, that there is a tendency in primary education, as well as in secondary and higher, to overload the programme of study more and more. It seems as if the aim were less to develop the intellectual capacity than to heap up knowledge upon knowledge in the head of the children at the risk of exhausting the intellectual force. This tendency is most injurious, but we hasten to say that already many important men, educational officials, have perceived that they were going by a false path, and are showing themselves disposed to make a change. Whenever the conviction shall become general that it is absolutely necessary at every stage to train the physical capacity, the manual faculties, from that day the programme of studies will be necessarily rearranged. Ability to use the hands is hardly less important to the sons of the middle class than to those of the working class. Indeed, there are many learned professions which demand a certain manual skill on the part of their practitioners. It is required for surgeons, architects, civil engineers, engineering officers, artillery officers, nayal officers. All of these need to know how to work. The same is true of inventors who are so often prevented from profiting by their ingenuity because they cannot put their invention into tangible form. Even literary men themselves, and all men whose profession is purely intellectual, would be fortunate in many cases to find relaxation for the mind in manual exercises and in executing certain useful works. This is for all men a natural need. It must needs be satisfied, and the level of the general capacity will be made higher by so much.

To conclude, the complement of education, which is here considered, is desired by nature itself. It is desired by the general public sentiment, and required as a means of responding to the inventive and transforming genius of modern society; and, finally, it is required by the solidarity of the faculties of the human being. Let us add, that it will be impossible to point out any disadvantages in it, but that, on the contrary, it possesses nothing but advantages.

A. CORBON.

The foregoing report of Senator Corbon has not before been translated into English, so far as we are informed. Senator Tolain's report, which follows, has been reprinted by the British Royal Commission on Technical Instruction, and by the United States Bureau of Education. We borrow here the translation of the former:

Monsieur LE PREFET :

SIR: This (second) sub-commission was appointed to examine into the question of Apprenticeship Schools, and they unanimously recognized the necessity for establishing these useful institutions.

Various causes have, since the year 1789, successively contributed to lower the standard of technical knowledge and of manual dexterity among workmen. For-

merly the classes organized by each trade association, and the execution of certain "master-pieces," which required both from the journeymen and from the master, constituted a system of true technical instruction, which, however, disappeared with the revolution.

In some trades, it is true, the status of "journeyman" survives, but it has been, and still is, steadily on the decline; industrial changes and facilities of intercommunication are gradually tending to its total abandonment throughout France.

Division of labor, meanwhile, has become more developed every day, increasing the number of "specialties," until each operation is reduced to a trade of itself. Finally, the steam engine has conduced to the establishment of large factories, where the machine tool plays the most important part, machine work gradually replacing hand-labor and transforming the artisan into a specialist and the workman into a laborer. Such then are the causes which, to the great regret of our manufacturers, are steadily diminishing the number of skillful and intelligent workmen in all branches of industry and art manufacture.

Again, the workshops where private industries are conducted no longer, except in a few rare instances, adopt the system of a true apprenticeship. The majority of manufacturers have given up taking apprentices; the lads they employ are set to a special class of work, often of the most insignificant kind; receive renumeration from the first; and, by mutual consent of the parents and employer, the contract of apprenticeship is abandoned for one of hire.

A revolution of this nature in the methods of production threatens above all the prosperity of French industry, and more particularly the welfare of that of Paris.

Among the trades and handicrafts, embracing art applied to industry and to objects of luxury, owing to the applications of science and the employment of machine tools, the articles produced assume a uniformity of character which diminishes, in a marked manner, their artistic value, and facilitates foreign piracy and imitation.

The Germans, the Belgians, the Americans, discover by means of new systems of working, and by the aid of improved tools, a means of appropriating to themselves, with little expense, patterns, the production of which has often been very costly to our manufacturers.

These disadvantages are equally serious from a moral point of view. The workman, deprived of the most noble part of his calling (the creative portion of the work being from henceforth reserved for the engineer and the artist), his own ideas dispensed with, reduced to mere imitation, and condemned to labor of the most mechanical kind, falls by degrees into a species of mental sloth which renders him unfit for any intellectual effort. Labor soon becomes to him subjection to an aimless toil, from which he, too frequently, seeks to escape.

In view of this condition of affairs the Commission recognized that what was needed was not a system of technical education in favor of a privileged few, destined to become foremen or managers of works, but to raise the standard of theoretical and practical technical knowledge among all classes of workmen.

The Commission, having in view a generalized system of education applicable to both boys and girls, had to consider the financial aspect of the question. Doubtless it is the business of the municipal council to remove the inherent difficulties in the way of establishing new institutions, in accordance with the State of its finances; but, notwithstanding the great resources of the city of Paris, it is evident that we must proceed gradually, and the method to be adopted is not a matter of indifference.

In the first place we were enabled to establish the fact that the various industries carried on in Paris may be divided into two great categories, viz: Parent industries and special industries. It is certain, for instance, that, for working in wood and iron, a systematic education, both theoretical and practical, would give to a lad leaving a municipal apprenticeship school, such as the school of La Vilette, the opportunity of following several trades and specialties; whilst on the other hand, workmen in such important industries in the clothing trades, as tailors, shoemakers, hatters, etc., are confined to their own respective special branches.

Now it is more particularly in the parent industries, comprising various trades or specialties, having numerous points of resemblance, the work in which is of a simi-

lar character, and renders necessary to a great extent, the same class of tools, that the system of apprenticeship is gradually disappearing; whilst employers are powerless to remedy the evil, however sincere may be their desire to do so. For these great industries, the only means of raising the standard of technical knowledge is the establishment of apprenticeship schools.

With these facts before us, a difficulty, however, still remained to be overcome. So long as hand labor, or speaking more accurately, the handling of the principal tools, forms no part of the education given in elementary schools, the apprenticeship schools will, in a great measure, be recruited in a haphazard way, since no opportunity will have been afforded for discovering the natural aptitudes of the pupils and determining their future vocations. Thus the education, however well organized, will not give such results as might otherwise reasonably be expected.

Without such preparation it is impossible to discover whether the pupil is specially fitted for work requiring precision or taste, for trades necessitating mathematical knowledge or artistic feeling. This difficulty is destined to be overcome by degrees, in proportion as manual work becomes extended in the workshops annexed to elementary schools (and by this means we shall certainly be able to shorten the erm of apprenticeship by one year); this difficulty, however, must be encountered at the beginning, and may give rise in some minds, to doubts as to the real value of the education to be obtained in apprenticeship schools.

Without departing from the principle already laid down, the Commission proposes to group together in the same apprenticeship school a certain number of trades; the programme of the school, whilst giving the same instruction during the first year to all the apprentices, would, in the second year, enable them to apply themselves specially either to works of precision or to those requiring artistic taste.

Inspired with this idea, the Commission proposes, by way of example, to establish an apprenticeship school for the furniture trades in the Faubourg St. Antoine, which would produce workers in wood who, according to their natural aptitudes, would take up either the trade of a carpenter, a cabinet-maker, upholsterer, wood-carver, inlayer, etc.; and workers in iron, who would become lock-smiths, men skilled in metal work for cabinet-makers and artistic lock makers. This example we consider sufficient to indicate the object to be aimed at with regard to each large branch of Parisian industry, viz: The grouping together of trades, which at the commencement of the apprenticeship, would require the same theoretical and manual instruction, and would permit of the distribution, by successive selections of the apprentices in accordance with their aptitudes, amongst the trades which involve more especially the knowledge of science or of art. Such is the system which the Commission proposes to adopt for the present industries.

It remained to determine what should be the conditions of admission to the new establishment. It was unanimously resolved that the admission should be absolutely free. A question then arose concerning the necessary qualification. Two plans were proposed; the first was that only those pupils should be admitted to the schools who held a certificate of primary studies; the second only required the student to pass a special examination of a very elementary character.

Is it, indeed, certain, asked the partisans of the examination plan, that the certificate can be regarded as a guarantee of capacity for the exercise of a handicraft? Assuredly not; all the faculties do not follow the same general groove. Although there may be some so constituted that they can do nothing without having first mastered the reasons for their actions, there are many, in fact by far the greater proportion, who should begin by practice and not by theory. This is especially true in matters of education, where we often proceed from sensations to thoughts, from particular facts to general laws, to return later from the rule to its application.

To require the certificate of primary studies would be to limit the number of competitors, and to reserve these new schools for the children of the less needy classes, for those whose parents have been able to keep them at the elementary schools until they obtained their certificate.

All men, however, who had specially interested themselves in the question of elementary education were unanimous in declaring the beneficial results arising from the system of certificates. If the certificate were not made obligatory for ad-

mission into the apprenticeship schools, competent judges feared that the spirit of emulation would be weakened. That this distinction is a powerful stimulus to exertion is proved by the fact that the number of certificates distributed yearly is always increasing. These reasons appeared conclusive, and the obligatory production of the certificate was adopted by the commission.

According to the calculations of a member of the commission, Mr. C. Lucas, an architect who is fully competent to form an opinion, and who has devoted himself with the utmost attention to this question, it appears that the cost of establishing an apprenticeship school (without reckoning the site) would amount to a sum varying from $360 to $400 per apprentice, according as the number of apprentices varied from one hundred to three hundred. It is necessary to observe that, in the opinion of the commission, and according to Mr. Lucas' plans, the class-rooms and amphitheatres could be so arranged as to accommodate a number of students attending evening classes, double that of the apprentices.

The special reports appended to the present one, concerning, the three schools for boys which the commission proposes to establish, contain detailed and precise information relating both to the programme to be followed and to the apparatus required. From these it would appear that, for the supply of both large and small tools, an average outlay of from $10 to $14 per apprentice would be necessary, according to the trade. Finally, the accounts of the school at La Vilette show that the annual expenditure will amount to $50 per apprentice.

As regards special trades the commission is of opinion that the manufacturers should themselves take the initiative, and it observes with satisfaction that in several industries the employers have not awaited its advice, but have, in some instances, already established, or are ready to establish, workshops for apprentices, whilst others are engaged in organizing classes to supplement the practice obtained in the workshop with theoretical instruction. In such cases, after having taken into consideration the programme adopted by the founders, and after having examined the guarantee given for the organization of a sound apprenticeship, the municipal council might come forward with a grant, on condition that its supervision were accepted and made efficacious, and that the apprentices were selected from among the pupils who had passed through the workshop attached to the elementary school.

In the case of schools for boys, the commission has confined its labours to three schemes. It would, indeed, have no further interest in continuing its enquiries if the municipal council were not to agree in principle to the proposed system.

The first would be a school of furniture and locksmith's work, situated in the Faubourg St. Antoine, comprising workshops for carpentry, cabinet-making, inlaying, chair-frame making, wood carving, builders' ironwork, cabinet lock, artistic lock making, &c. (Report of M. Coughny.)

The second would be a school for engineers and wood-workers, to be established on the left bank of the Seine, after the model of the school of La Vilette, but with certain additions which would permit of a larger field of instruction. These additions would comprise stone-cutting and working, timber construction, foundry work, also iron and tin-plate working, roofing and plumbing; which would make of this school a thorough apprenticeship school for the building trades. (Report of Mr. Henry Lepaute.)

The third, to be situated in the centre of Paris, would combine the following specialties: scientific instruments, optical and mathematical instruments, telegraphic apparatus, small machinery, clock making, surgical instruments, &c. (See Mr. Bourbouze's report, specially relating to scientific instruments.)

The commission would have accomplished but half its task if it had not considered the question of apprenticeship schools for girls; but as women's work does not present such diversity and so many complications as men's work, Messieurs E. Ferry, de Heredia, Marienval and Charles Lucas, who have especially occupied themselves with this question, have drawn up one general programme which might be adopted in various quarters of Paris. (See data relating to the apprenticeship school for girls, collected by Mr. Charles Lucas.)

The Commission, as you will perceive from its report, wishes to make this apprenticeship school a school also for domestic training. Girls going into workshops

at an early age accustom themselves afterwards only with much difficulty to domestic duties, and further, owing to the want of elementary knowledge of these subjects, they are unfitted to undertake them. We hope that the programme proposed will improve this condition of things.

The educational authorities ("*Direction de l'Enseignement*") have transmitted to us several other schemes for the establishment of apprenticeship schools, but as they differ too widely from the plan adopted by the Commission, we have, notwithstanding their undoubted merit, been unable to recommend them.

The same may be said of the private workshops for which a grant was asked from the municipal council.

In concluding, we have to tender our thanks to the officers of public instruction, who, by their intelligent zeal, have, in conjunction with the municipal council, succeeded in establishing the first apprenticeship school of the city of Paris, viz., The Municipal School for Apprentices in the Boulevard de la Vilette. This school, like all new institutions, encountered certain difficulties at the beginning which were fortunately overcome.

The experience thus acquired ought to be made use of in establishing the new institutions, and we may, therefore, add the following remarks:

The majority of the children going into the apprenticeship schools will belong to parents with large families. Under these circumstances, good-will alone on the part of the parents will not suffice to maintain the apprentice for three years without any remuneration whatever. It happens too often that a good apprentice, belonging to a poor family, may be compelled to quit the apprenticeship school at the end of the first or the second year, that is, as soon as he has received sufficient instruction to enable him to earn something at a trade.

Industry would in this manner be supplied with imperfectly trained workmen in spite of the considerable sacrifices undertaken by the city of Paris. For these reasons, therefore, and prompted by the experience gained at the school of La Vilette, the Commission deem it desirable to point out how the evils of a premature withdrawal from the apprenticeship school may be averted.

From the beginning of the second year the school might furnish gratuitously to all, or to a certain number of the apprentices, the mid-day meal, and in the third year add a small weekly remuneration. If the resources of the school permitted of this, a savings bank book, or a fixed sum, might be allowed to the apprentice, either to assist him till he can earn his living in a factory, or to enable him to provide himself with tools in the cases where this expense falls upon the workmen.

If the ideas herein set forth should be of value to the development and progress of industry, the Commission, Monsieur le Préfet, will have to thank you sincerely for the opportunity that has been afforded to it of being useful to its country.

A. TOLAIN (Senator.)

It will be observed that the foregoing reports deal respectively with two distinct phases of the subject: its feasibility and desirableness, first, as a branch of training in connection with the ordinary studies of the primary schools, with pupils ranging from 6 or 7 to 13 years of age; second, as a special branch of what is now, in France, generally called "professional" instruction, carried on in separate establishments, under the joint control of the departments of Public Instruction and of Commerce and Industry, and having an educational as well as a technical or industrial aim.

The term "primary" schools as used in the French system has a more extended meaning than in the United States. There it designates, in general, the entire range of compulsory public education.

When the pupil has completed this "primary" course, he (or she) is at liberty to begin the occupations of life, or to enter a "superior

primary school," or "a manual school of apprenticeship"—both of the latter being, however, in the eye of the law "primary" schools but something more. To such a school no one is admitted without a certificate showing that he has completed the "primary" studies prescribed by law. The course continues three years. The first year is devoted to a continuation of the principal branches of previous study, and to a course of training in the elementary branches of working in wood and iron. During the second and third years, the educational studies are continued and the "professional" studies become more specialized, including the elements of various trades, as cabinet making, harness making, watch making, jewelry, etc., etc. The courses of training are based upon the idea that youth, at the age of 11 to 13 required for admission, can profitably choose and enter upon a fixed employment, without unlearning everything else; that they can become virtually apprentices without ceasing to be pupils; that, with a proper distribution of time, they can acquire the practical training of workmen without losing the intellectual habits which form the man. Such institutions are designed to be at once schools and workshops; mainly schools at first, but more and more workshops as the course advances.

While they are "manual schools of apprenticeship," they have not in view apprenticeship to a special trade, so much as so secure the dexterity and the technical knowledge necessary for youth who are destined to engage in any of the manual professions. These schools are mostly established and supported by the municipalities under the supervision and with the aid of the National Government.

The working of the system in its various branches is best shown, of course, in the city of Paris. What is being done there was very fully shown in a paper entitled "Professional Instruction in the City of Paris, read by M. Desmoulins, before the *Congress International ayant pour objet l'Enseignement Technique, etc.*, held at Bordeaux, September, 1886," of which we give here a translation:

"My purpose is to make you acquainted with the actual state of industrial, commercial and technical instruction in Paris and in the Department of the Seine. I have some right to occupy you with this subject since I belong to the Municipal Council of Paris, and the council general of the same, and am the reporter of the Budget relating to instruction. It is a difficult matter, and it will be necessary for me to cite figures. In this, I ask your indulgence. The city of Paris has an annual budget of instruction which is not less than 25,000,000 francs. This budget includes all the expenses of public instruction of the city of Paris, but most of these expenses have a very great utility in respect to industrial, commercial and technical instruction, so that in speaking of them I shall not for a moment depart from the principal question which is presented to us. At Paris, primary instruction is given in the following establishments:

126 maternal schools.

17 infant schools.

174 primary schools for boys.

175 primary schools for girls, making a total of 492 schools for primary instruction, in which about 145,000 pupils are taught. The personnel charged with this instruction includes not less than 3,000 members. About 1,500 men and 1,500 women. The appropriation required for their payment is about 9,500,000 francs. The maternal schools have succeeded the ancient Asiles which were only refuges. The most of these schools are now provided with Froebel's apparatus. Lessons in things are there given, which are in many respects a technical instruction. Singing and drawing are taught. One of the inspectors of drawing, M. Ottin, the eminent sculptor, has already introduced into a number of these schools exercises which are a veritable gymnastic for the eye, the thought and the hand, and which familiarize the pupils little by little with those elements of drawing which will permit them later to attain the "writing of form." There can be seen at this moment in Paris, at the Exposition of Decorative Arts, copy books and show cases filled with drawings of little boys and girls from 6 to 8½ years of age, very remarkable for ingenuity, steadiness of hand and originality. I think manufacturers could make use of some of them for stuffs, embroideries, etc. My colleague, M. Chabert, will speak to you presently of the services which these elementary exercises render to our education. Of the 174 boys' schools, 95 are already provided with workshops—90 for wood work, and 5 for iron. It is not the purpose there to teach trades. The design is to give the pupils a primary technical instruction in order to secure them a general and practical knowledge of materials and tools. I regret that similar shops are not yet established in all the schools. Up to the present time these workshops have been used outside of school hours. The work was performed in the morning before the beginning of the classes, and in the evening after their close. The inconvenience of this system struck the department council of public instruction, which has just arranged the basis of a new distribution of time according to which the manual tasks will take place in the daytime, and will become a part, in the same way as gymnastics, of the regular studies of the school. This new schedule is to be applied very soon, and the city of Paris will find itself obliged for this purpose to provide shops for 79 boys' schools which do not yet possess them. I would wish you to observe carefully the necessity of placing tools in the hands of our children. This gives opportunity for a multitude of practical demonstrations which belong to science, but which do not present science under the abstract form which the child often fails to understand. The question has been asked whether it is well to introduce elementary workshops into the school, but their utility has been recognized. We hope that the city of Paris will establish shops in the 174 boys' schools. For the girls

the thing is more simple. The law of 1882, at the same time that it introduced elementary labor into the schools for boys, introduced cutting and fitting into all the schools for girls. The result is that the 175 of which I speak are veritable little shops of cutting and fitting.

I now come to speak of infant schools of which the city of Paris has 17. Little children are there taught the elements of knowledges which will be useful to them later. There is nothing more delightful than to watch the eagerness of these little children in their exercises. They fashon objects which later will have an industrial utility. The children question their teachers, and immediately obtain responses. They are delighted. They are happy at school and when any circumstance prevents their attendance they are greatly distressed.

When these little children go from the maternal school to enter the primary school, they find themselves restricted by the great number of their companions, by a discipline, a silence, a stiffness which have nothing in common with what they have seen in the maternal school. By means of these 17 infant schools, municipal council has intended to fill up the gap which exists between the maternal school and the primary school. These schools are directed by women. Pupils are received from 6 to 9 years of age, and an important service is rendered to them. The methods of the maternal school are there continued in a certain degree. The intelligence of the children begins to develop, their memory is made more sure, their judgment is formed. It is said: "These children will regard a woman as beneath their little dignity," but the experiment has completely succeeded. Women have gifts for instruction which men acquire with difficulty. Our 17 infant schools already render such services that the question is raised whether it will not be feasible to entrust to women the entire elementary course of the primary schools. * * * * Our existing system of education is made of pieces and morsels. It is important that it be reduced finally to a single plan.

Thus, with the exceptions indicated, and which are about to disappear, the city of Paris has now established technical instruction in all its primary schools. See, now, what it has done for a more advanced grade. In the first place comes the College Rollin, a city college in which are taught the subjects which appear in the programme of the University. We may say that the College Rollin is a State College. The only privilege the city has is to pay the expenses. The direction of it belongs to the University.

The College Chaptal is more a city college. There we prepare a great number of young people for commerce. Some go to the polytechnic school; two or three have been received there this year. Forty-five or forty-six of the students have been graduated as bachelors of science or bachelors of letters this year. These two colleges instruct about 2,400 youth.

I come now more particularly to the Superior Primary Schools, namely: The Turgot, Colbert, Lavoisier, J. B. Say and Arago.

The better scholars of the Primary Schools are admitted gratuitously to the Superior Primary Schools. These schools are in many respects professional schools. There are prepared especially commercials and employés. In the Turgot, there are 810 pupils; in the Colbert, 714; in the Lavoisier, 480; in the J. B. Say, 683; in the Arago, 476; making for all these schools about 3,163 boys. Paris has also a superior primary school for girls, which counts not less than 280 pupils (Rue de Jouy). The most of our schools, except the Rollin, have workshops for manual labor. This preparation is useful, for the greater number of our pupils devote themselves later to those industrial arts which form the principal wealth of Paris. Moreover, it is for us of the highest importance in a moral point of view, to accustom all our youth to labor, and to direct them toward careers which might otherwise be called menial. It is not for nothing that so experienced a city as Paris endeavors to destroy in their sources the causes of uneasiness, by showing to all the Parisian youth that they are summoned to the great honor of contributing, by laborious activity, to all which can elevate the nation. It is time at last to elevate labor to the height which it ought to occupy.

I come now to the course for adults. The city maintains courses for adults and commercial courses. The former are taken at Paris by less and less numbers. The commercial courses on the other hand render services which the public appreciates more fully day by day. It is necessary to note also courses maintained by various societies of instruction—polytechnic, philotechnic, etc., which are supported with great eagerness by the Parisian youth. Accordingly, the Municipal Council each year diminishes the sums appropriated to the adult courses, and increases those for the commercial courses, and for the public societies. Instruction in drawing costs the city of Paris almost 1,000,000 francs. I recognize, however, that this instruction does not produce all the results to be desired. The professors are men of ability. They are mostly animated by the most laudable zeal, but they rightly complain of defective methods in the succession of classes. In reality, they give their instruction in the principal courses of the primary schools, but too large a number of their pupils have received in the elementary instruction and secondary courses only a too incomplete, and, in the majority of cases, badly directed preparation. The result is a notable loss of time and effort. I ought to add that by force of ability and perseverance the professors, in spite of these obstacles, obtain remarkable results. The workmen's exposition, and the exposition of the arts applied to industry, enable the public to judge of this progress. Works produced in the day classes, and in the evening courses are there exposed. The articles produced by the scholars of the courses of the Rue Sainte-Elisabeth, and of the

Municipal School for the application of the fine arts to industry—Rue des Petits-Hotels—attract attention everywhere. This last school includes four shops: 1. for pottery; 2. for wood-cutting and stone-cutting; 3. design on materials, stuffs, etc.; 4. decorative painting. Thus, in these schools, the young people who labor in the workshops all day can in the evening pursue the course of the history of art. They are taught the elements of the different arts applied to industry. For example: what was a vase among the Greeks; what it became at the Renaissance. The professor draws upon the board the outline of the object; the pupils copy it in their albums and note the explanations given. One may then say to these young people: "make a wash basin, an ink stand, or any industrial object whatever." They are directed as to the epoch which they are to represent, and are then left absolutely free. I have seen compositions thus made. Not only did the drawing recommend itself by its conception and skill, but still further it was marked and ready for execution. In the presence of such results, the city of Paris has desired to place within reach of laboring youth schools which should be open by day. This is the case with the school for the application of fine arts to industry, Rue des Petits-Hotels. The city of Paris has shown thus how much it had at heart the great interests of industry and of commerce.

I come now to schools of apprenticeship. At the head of them stands the school of physics and chemistry, which comprises 90 pupils, 30 for each year. The pupils receive a monthly grant of 50 francs. The city is recompensed for these sacrifices, and industry already enjoys services rendered by the specialists sent from these schools.

Next comes the Municipal School, Diderot. The circumstances under which this school was founded are not, I think, sufficiently known. Give me leave to recall them. The jury of the Universal Exposition of 1867, had agreed that the quality of the productions of French industry was undergoing a decline which could only be attributed to the failure of apprenticeship. A remedy was sought. The municipal commission of the city of Paris voted a prize of 250 francs for each young workman who had fulfilled the requirements of a contract of apprenticeship of 3 or 4 years. Do you know in what proportion these prizes have been claimed? In the proportion of 2½ per cent. Thus only 2½ per cent. of the young workmen had served a regular apprenticeship. When the council elect took charge of the municipal finances, it found in the Treasury about 60,000 francs appropriated to these prizes which had not been claimed. It devoted this sum to the foundation of the school of the Boulevard de la Villette (Diderot). The school Diderot has not less than 330 pupils; eight trades are taught there—six of iron and two of wood. The principal difficulty has been to retain pupils in the shops until the end of their third year. The first year is given to rotation, that is to say that during these first 11 months, the scholar passes successively

into the eight shops of the school. This practice gives so good results by the general and practical knowledge which it imparts to the pupil, that in the second year, when he makes choice of a profession, he becomes sufficiently skilful to make his labor already valuable. The industrials of the neighborhood of the schools observed these pupils of the second year, and by the attraction of a salary induced them to engage in their services. From this it followed that a very small number of pupils completed the third year. Four years ago the school, which already numbered 270 pupils, did not add to the industries of Paris more than 25 pupils of the third year. The council of supervision appointed to the school by the municipal council attempted to overcome this difficulty. They succeeded in providing payment for the breakfast of about a third of the scholars of the school [The Parisian breakfast for schools occurs at about 11 or 12 o'clock, and is in almost all cases taken at the schools, either being carried there by the pupils or provided there free or on a small payment]. They organized a refreshment room [*cantine*], made distributions of prizes, granted prizes to the most meritorious scholars of the third year, and gave them vacation trips. Thanks to these arrangements the school has this year sent out to industry 75 scholars of the third year. A diploma is given to these scholars of the third year which is equivalent to a veritable certificate of apprenticeship.

This diploma is highly appreciated by the industrials. The present month a second school of apprenticeship opens, the furniture school, situated in the Rue de Reuilly. Furthermore the city of Paris has this year taken charge of the orphanage of the Avenue Philip Augustus, in which about 100 young boys learn different trades in iron and wood. Combining these numbers of pupils, we find :

School of Physics and Chemistry, ...	90
School Diderot, ...	330
Furniture school, ...	60
Orphanage, Philip Augustus, ...	100
Total (boys learning trades), ...	580

The girls have not been forgotten. The city has established or adopted for them 5 schools of apprenticeship called professional and housekeeping schools, [*Menageres*] :

Rue Fondary, ...	180	scholars.
Rue Bouret, ...	123	"
Rue Bossuet, ...	200	"
Rue Ganneron, ...	130	"
Rue de Poiton, ...	170	"

If we add to these figures the number of pupils in the superior primary school of the Rue de Jouy, we see that about 1,083 young

girls are preparing for trade, for cutting, for painting artificial flowers on porcelain and fans, etc. Nor should I overlook the instruction in domestic and household economy which is given to them both theoretically and practically.

I cannot close without speaking to you of the careers which we attempt to open to these young girls. The first is book-keeping; also in some schools we have carried commercial courses as far as possible. These are so far complete at present that they comprise the English Language, practically taught. Drawing is perfected so far as to prepare the young girls for pottery, for painting on fans, for the making of artificial flowers, and for all other applications of painting. Then comes cutting. Already our schools have sent their products to the national and international expositions which have been opened in recent years, and have there obtained prizes. There, Ladies and Gentlemen, is what the city of Paris does with the 25,000,000 francs which is appropriated for education. Thanks to modern progress, all good tendencies converge toward this result: to raise the *morale* of our country, to develop in our youthful generations that which you will permit me to call the primary virtue—the love of labor—and it is the most encouraging thing to see great communities like Havre, Lyons, Bordeaux and Paris, encourage everything which is calculated to place labor in honor. A happy impulse is now impressed upon it. Let us hope that the movement will receive no check, and that it will prepare youth who will contribute more and more to the grandeur and true wealth of the country.

The National Professional School of Vierzon.

After the passage of the law of December 11, 1880, authorizing the establishment of Manual Training Schools, the promoters of the movement actively interested themselves in seeing that the first steps should be wisely taken. A commission was appointed May 31, 1881, to prepare a plan of studies and organization for such schools, with Senator Tolain as President. The Commission also included M. Buisson, who is well known in this country and whose indefatigable and intelligent labors in behalf of public instruction in France been of inestimable value; M. Jacquemart, inspector-general of the National Schools of Arts and Trades and of Technical Instruction; M. Salicis, of the Polytechnic School, besides others whose names are not so familiar. On the 11th of the following August, Senator Tolain presented the following report of the Commission, which may be regarded as an expansion in one direction of the general principles discussed in the report already given, pp. 439–43:

"This commission has the honor to present to you to-day the result of its labors. Article 1st of the Law of December 11, 1880, relative to the manual schools of apprenticeship, is thus expressed: 'The schools of apprenticeship founded by the communes or the departments to develop the necessary dexterity and technical

knowledge in youth who are destined to the manual professions are placed in a number of schools of public primary instruction.

The public schools of complementary primary instruction, whose programme includes courses or classes of professional instruction, are assimilated to the manual schools of apprenticeship.' The Law of December 11, 1880, was suggested to its authors by the truthful remark that, in France, the professional value of the workmen of almost all classes showed a tendency to decline since a certain time. This regrettable condition of things, which would involve for the future of our national industry the gravest consequences, is due in great part to the fact that for various causes mentioned and analysed by Messrs. Nadaud and Tolain in their reports to the Chamber of Deputies and to the Senate, that apprenticeship no longer exists so to speak in our country.

This situation could be remedied only by encouraging the creation in industrial centers of special professional schools for each branch of industry, able to replace and even more than replace what apprenticeship had formerly been for young people. The utility of the creation of such establishments needs no longer to be shown. A number of industrial centers have recognized it, and have taken in this respect a praiseworthy initiative. Thus there have been founded at Paris the municipal school of the Boulevard de la Villette (Diderot); the school of watchmaking; at Reims, the professional municipal school where dyeing, spinning and weaving occupy the principal place; at Nimes, the manufacturing school for the various tissues, which have made the fortune of that city: at Limoges, the school of ceramics; at Douai, at Havre, the schools of apprenticeship, etc. This being the situation, the Law of December 11, 1880, has a double purpose: First, to form in the special schools of apprenticeship and train for the industries workmen completely initiated to the labor of their profession; Second, to give the manual dexterity and the technical knowledge necessary for young people who propose to enter the special schools of apprenticeship of the secondary grade.

It is in this view, M. le Minister, that you have been anxious to create a National School of superior primary instruction, and of professional instruction, preparatory to apprenticeship, destined to serve as a type for establishments of the same kind which will be founded under the law. It is the programme of this school which the commission named by the decree of May 31, 1881, has been charged to elaborate. The commission was of opinion that such an establishment should include a Salle d'asile, a primary school, and a professional superior primary school; furthermore, that, with a view of preparing for the future a body of teachers fitted to conduct the practical exercises given in these schools, it would be desirable for the State to send a certain number of assistant masters of the normal schools to spend in this institution time enough to acquire the knowledges in which they were actually deficient. It was also understood by the commission, that by reason of the definite character of the projected schools, all specialization in manual instruction was to be avoided. The projected school should then include: 1. The Salle d'asile, receiving children from 3 to 6 years; 2. The primary school receiving children from 7 to 12 years; 3. The superior primary school, in which children should be admitted from 12 to 14 years; 4. The section of assistant masters. The problem was to determine a continuous series of manual exercises during this period, as a result of which the child, on leaving the superior primary school, would find himself possessed of dexterity of hand, and at the same time of a certain amount of technical knowledges. The commission has thought that the programme which accompanies the present report would answer this object. So far as concerns the Salle d'asile, the application of Froebel's method, suitably extended and developed, will completely satisfy all the requirements of the general plan. At the age of 7 the child enters the primary school. He will remain there until the completion of his 12th year, as a rule, that is to say 6 years. In order to form a more exact estimate of the kind of manual labors in which children of the primary school should be exercised, it is proper to consider the grade of knowledge which it is desirable for them to have on leaving the superior school. The indispensable, theoretical knowledge appears to us exactly specified in the programme established by the ministerial decree of January 15, 1881, relative to the superior primary schools of three years. As to the practical

knowledge, the commission has thought that it would be possible to assure it to the pupils of the superior primary school under favorable conditions by a progressive manual instruction which should be limited to two hours a day during the first year, but occupy almost the entire time during the third. From this observation it follows that it would not be necessary to place tools for working wood and iron in the hands of the child before the age of 12 years. Nevertheless, there is reason to think that from 10 years onward the labor of the shop would not be injurious if properly directed, and if one is careful to place in hands still weak and untried only such tools as are proportioned to the muscular strength of the pupil, and so chosen as to avoid injuring the development of an organism still forming. Children of 11 and 12 years will then be already familiarized in some degree, with most of the tools employed in wood-working; will be exercised in turning, and will have begun to use the file. Skill and nicety of touch will at the same time be cultivated by the practice of modeling. As for the period from 7 to 10 years, there should be no attempt to do more than develop the manual dexterity of the child by slight labors demanding almost no expenditure of physical strength; drawing, carving, the arrangment of bits of card in order to obtain objects of various forms and colors will exercise at the same time attention, intelligence and ingenuity. To these labors may be joined the execution of small objects in basket work, and the making of mechanical lattice work, requiring the employment of only a light tool. An effort should be made from this period to induce the pupils to make objects which they can carry home, and show as their work. Some specimens marked with the name of each should remain at the school, and form the beginnings of a school museum. From 7 to 10 years, modeling should hold a certain place in the school exercises. The child leaves the primary school and enters the superior school. The age which appears most suitable if he is to become a workman is 12 years. The child leaving the school three years later at 15 or 16 years will find himself in more favorable circumstances either to enter a special professional school of the secondary grade or to perfect himself very readily as a workman in industrial establishments. The manual exercises of the superior primary school should have as a foundation, in the opinion of the commission, the working of wood and of iron. In fact labor upon these two materials offers an almost unlimited field for the general and unspecialized preparation, which pupils ought to receive. The working in wood and in iron will alternate so that, at the end of the year, the pupil will have been exercised during two periods of 60 days in each of the two shops. The two kinds of labor connected in this way will complement each other. It is thus that after having studied the practice in wood turning, one will be able to pass more readily to the turning of metals, and that after having constructed any piece of joinery whatever one will be better able to meet the difficulties presented by the fitting of two pieces of metal. In the superior primary school, drawing should consist, during the first year, of exercises in outline and in color, the object of which will be to secure precision and firmness of execution. In the second year, architectural and ornamental drawing will be combined with work in modeling. Free-hand drawing should hold one of the most important places in this branch of instruction. In the third year, the exercises in drawing will consist principally in sketching and in drawing, with sections and sides, the different tools and instruments employed in shops. The shop work of the pupils will in all cases be executed according to sketches made by them from the pieces themselves.

Such are, M. le Minister, summarily expressed, the general ideas according to which the programme, which the commission has the honor to submit to your examination, has been prepared.

The question respecting the assistant masters of the normal schools, it has seemed best for the present to reserve."

[NOTE. The course of study recommended has already been given, pp. 432–4, above.]

On the 9th of July, 1881, the President of the Republic decreed the establishment at Vierzon of "a National school of Primary instruction and of Professional instruction preparatory to apprenticeship,

destined to serve as a type for institutions of the same kind," as provided for by the law of 1880. The city had already voted the funds, chosen the location, and prepared plans. In 1883, the corner stone of the building was laid by M. Brisson, then President of the Chamber of Deputies, in the midst of a distinguished audience of citizens and officials, and with every circumstance calculated to express and to increase public and private interest in the new institution.

The address of the occasion was delivered by M. Jules Ferry, in which were set forth with admirable clearness the purpose of this and similar institutions, and the views of the Government in fostering them At the risk of incidental repetition of what has been already said, we translate the address in full:

"GENTLEMEN:—The President of the Chamber has already defined, in excellent terms, the work of which we here lay the corner stone. If the Government of the Republic has chosen the city of Vierzon in order to make here this great and decisive experiment, it is because Vierzon is before all and above all a city of labor; because it owes everything to labor, and from labor only can expect its development and its future, and because, thanks to the special situation which nature has given it, it unites and represents at once mechanical and agricultural industries. These are the titles of Vierzon to the preference of the Government. This is why we are founding here not only a school designed to subserve local needs, but an institution truly worthy of this name, National School, which we have given to it. We wish to attempt here and to realize on a large scale an idea which the First Republic pursued and cherished; which it formulated with remarkable precision, and which has found renewed favor in the public mind whenever Democracy has made a step in advance, as well after the Revolution of 1830, as after that of 1848. This creative thought, this settled purpose, which had its origin in our country nearly a century ago and which to-day finds itself realized, the idea which should be engraved upon the front of this edifice is, that the National School in a democracy of progress like ours should be essentially a school of work.

"Yes, gentlemen, it is from this point of view that we have revolutionized the school. We have begun this beneficial transformation, and if the future is granted to us, it shall suffer no harm in our hands.

"The supreme purpose, the final aim, the essential mission of the modern school is the education of this democracy of workingmen who are not only a majority in numbers, but whose vigorous virtues make the strength of the country.

"Thence arises the professional character of our primary education as it is established in the new programmes. I say it aloud, and I mark this fact, important to the laborers who listen to me and to whom we can allow it to be said that our policy is, in respect to what concerns them, not barren or indifferent. The primary school

of to-day which we have organized after the ideal entertained by the French Revolution—this little school is from its first hour professional. That is to say, its aim is to prepare the child to become like the immense majority of French citizens, a workman.

"In truth, gentlemen, what are these new methods which we see applied in the school? What are these lessons about things—these school museums in which the industry of master or of scholars labors to gather the different products either of the soil or of the local trades? What is all that if not the beginning of the first form of professional instruction, the elementary preparation for that practical life, that laborious life, which gives to each man in this France the right to carry his head high and call himself a citizen.

"All new programmes rest upon this double idea: First, That primary education in a Democracy should comprise at the outset a general education, without which there is no durable specialty, no solid and serious professional instruction; and in the second place in a series of exercises tending to place the child by progressive and well-arranged initiations, in contract with the realities of life. To form from childhood the man and the citizen; to prepare workmen for the shop, is our task, and if the present generation has time to fulfil it, it will be able to rest gloriously in its grave.

"Thus, gentlemen, are passed the first years of the primary school; but when the primary course has finished this first circle, as the President of the Chamber just now said, a singular and disturbing chasm (*vide*) opens beneath the feet of the youth: no more school, no more anything between his twelfth and thirteenth year and the beginning of apprenticeship. It is this chasm which we wish to fill by the professional school, and it is a typical professional school of this order that we wish to establish here. I desire to define clearly its character, and to estimate with precision its extent and bearing. We do not wish to create at Vierzon a professional school which duplicates or which copies the School of Arts and Trades of Chalons, of Aix, of Angers. No, those schools have a determinate end. They undertake to form superintendents—the sub-officers—for the army of labor; here we wish to prepare the soldiers for this army.

"Engineers, managers of works, designers, superintendents; these are the *cadres* of French labor and industry. It is not with these that we here preoccupy ourselves; it is with the great working mass itself. It is the laborer whom we wish to elevate. It is to him that we wish to give a practical and intellectual education which will render him superior to his daily task, and which, far from disgusting him with it or from withdrawing him from it, will attach him to it by a bond more intimate and more profound.

"Ah! gentlemen, I know the old doctrine—the aristocratic doctrine—which said: It is imprudent to give education to the people. It is imprudent to teach the workman anything beyond what is necessary

for his daily task. He will take a dislike to his trade if he once looks beyond its lowly horizon. That, gentlemen, is an aristocratic conception and a false conception. The democratic conception—which is ours—is precisely antipodal. We judge, in fact, that the more the workman shall be familiarized with the natural laws, of which he is too often the ignorant auxiliary, the better he will understand his daily labor; the more he will honor and love his trade.

"There is upon this point a fine saying of Channing, one of the men who have best loved the people and best known modern Democracy. Channing has made the remark that industrial labor—the labor of the shops—sets in operation incessantly all the discoveries of science and all scientific notions, the oldest as well as the newest, and he recommends statesmen to spread abroad in the shop these scientific knowledges, these positive conquests of humanity; for, says he, 'There is no more certain means of ennobling a manual profession than by showing the intimate relation which connects it with the natural laws of the world.'

"To ennoble manual labor, gentlemen, is our wish also. This purpose we have inscribed in large letters upon our programmes. The programme of moral and civic instruction decreed by the Superior Council of Public Instruction contains an article with this title: 'The Nobility of Manual Labor;' and in order that the nobility of manual labor may be recognized, not only by those who exercise it, but by the whole of society, the surest and only practical means have been taken; manual labor has been placed in the school itself. Be well assured that when the plane and the file shall have taken the same place—a place of honor—by the side of the compass, the chart and the book of history, and shall be the object of an intelligent and systematic instruction, many predjudices will disappear; many antagonisms of classes will vanish; social peace will begin on the benches of the primary school, and concord, with its radiant light will illuminate the future of French society.

"Gentlemen, the professional instruction which shall be given here will have for its distinctive character not to constitute a separate instruction for any single industry. It will be professional without specialization; it will teach the general principles upon which all industries rest; it will associate, for example, the notions which control the iron industry with those which direct the wood industry. During the three years which the young pupils of Vierzon shall pass in the professional school, between the twelfth and sixteenth year, they will become, without difficulty—trial of which has been made, the programmes arranged and time of studies fixed for the present—they will become experts in these two fundamental branches of manual labor, the working of iron and of wood. And what will be the consequence of this general professional education, which will not give a

trade, but which will render the pupil capable of learning much more quickly and much better that which he shall choose?

"This consequence will be double. In the first place, it is evident that the duration of apprenticeship will be notably reduced, which is a considerable advantage; and, in the second place, during these three years of study the child will have time to do what he can now do, choose freely, and with knowledge of his reasons, the career which befits him—determine his vocation; finally, he will be armed against that danger of mechanical specialty arising from the unlimited division of labor, which is one of the necessities of modern industrial progress, but the evil effects of which it is the object of human wisdom, of the wisdom of government and of the teachers of the people, to anticipate and to diminish. He will be able then to contend against a tyrannical specialization; he will be able at need to choose a trade, and will not be necessarily bound to the iron industry since he will also be well prepared for working in wood.

"This, gentlemen, is what I desired to say here of the distinctive character and practical aim of the new school. I do not hesitate to declare that it is one of the most popular and most democratic labors which one can undertake in these times, and I add that it is a work eminently National. Professional instruction such as we intend it to be we shall succeed in organizing, for we are marvelously supported by the movement of public opinion. There are upon this subject magnificent figures which I wish to indicate to you in passing. Professional instruction is already associated with superior primary instruction by more than one bond. Upon a lesser scale—in a less complete way than in our school of Vierzon—it may be regarded as formed, constituted and seriously established in four hundred villages or chief places of French cantons. And since what time, gentlemen? Since 1879. In 1879 the were forty superior primary schools and professional schools in France, which had sprung up almost at random through the good will of the municipalities and by the spontaneous movement of public opinion; and, since 1879, without other intervention than the holding out of a friendly hand, there have been created four hundred in this land of France.

"This instruction, gentlemen, which has, as you see, so deep roots in the Nation itself, responds to a double interest—a great moral and social interest, a great economic interest.

"Knowledge is, for the workmen, without doubt, a great instrument of power, of dominion over matter; but it is also a great means of quiet and pacification. The passions which foster anarchy are all the daughters of ignorance. To teach the workman not only the natural laws which he employs in the exercises of his trade, but to teach him equally the social law; to make him see clear amid these economic phenomena which the adversaries of existing society—which is, however, the most democratic and the most free of societies—seek to travesty

or to obscure; to give to the workman just notions respecting social problems, is greatly to promote the solution of them. What was in other times only a religious or sombre resignation to necessities not understood, may become, through the progress of knowledge and the habit of reflection, a considerate and voluntary adhesion to the natural law of things—an adhesion which compensates itself in some degree, by a more practical conception of the means by which one can lighten its severity.

"I have said, finally, gentlemen, that there is in this affair a great economic interest to consider. Surely France is a great laborious nation. It has carried away great victories on pacific fields, in free competition with Europe; but everything declares to far-seeing eyes that here, as upon other fields of battle, we must not sleep upon past victories. We have all about us, at our gates as well as beyond the Atlantic, most formidable competitions in free labor. Their products which reach us, the reports which are made to us, above all the competition which we meet in foreign markets, give us in this respect warnings which we must not despise.

"Thus, gentlemen, upon the field of industrial battle as well as upon the other, nations can fall and perish; upon this field of battle as upon the other one may be surprised; one may, by excess of confidence, by admiration of himself, or by sluggishness of the Public Powers, lose in a brief time a superiority professionally uncontested. It is for this great danger that Professional Industry in our country should prepare. There is no National interest more important, and I can say and repeat here, gentlemen, without fear of contradiction from any one: To elevate the shop is to elevate the country."

We cannot more fitly conclude our account of this class of institutions, than by quoting the words of the British Royal Commission, which are as applicable in the United States as in Great Britain. They say:

"In the whole system of French instruction your Commissioners have found nothing, except as respects art teaching, which seems to them to be so worthy of attention, with a view to their adaptation to the special requirements of this country, as these higher elementary technical schools."

Laws, etc., Relating to Manual Training Schools.

The Law of December 11, 1880, concerning Manual Schools of Apprenticeship, has been so often mentioned, that the following translation will not be without interest:

ARTICLE 1. Schools of Apprenticeship founded by Communes or Departments to develop in youth who are destined to the manual professions, the necessary dexterity and technical knowledge, are placed among the number of institutions of public primary instruction.

The public schools of complementary primary instruction, whose programme

comprises courses or classes of professional instruction, are assimilated to the Manual Schools of Apprenticeship.

ARTICLE 2. The Manual Schools of Apprenticeship and other schools at once primary and professional, founded and supported by the free [i. e. private] establishments, are placed in the number of establishments designated by Article 56 of the Law of March 15, 1850, as entitled to participate in the appropriations provided by the Budget of Public Instruction.

ARTICLE 3. The institutions designated in Articles 1 and 2, of the present law will be entitled also to participate in such appropriations of the Budget of the Ministry of Agriculture and of Commerce, as are designed for institutions of technical instruction.

ARTICLE 4. The programme of instruction of each of these institutions is fixed by decree, following a plan elaborated by the founders and approved by the Ministers of Public Instruction and of Agriculture and Commerce.

ARTICLE 5. In schools founded by Departments or Communes the director is appointed in the same manner as all public instructors; on the nomination of the Municipal Council if the school is founded by a Commune, or by General Council, if it is founded by the Department.

The personnel charged with professional instruction is appointed by the mayor in case of a Communal school, or by the Prefect in case of a Departmental school, on the nomination of the Commission of Supervision and Perfecting appointed in connection with the institution by the Municipal Council or the General Council.

In private schools the whole personnel is chosen by the founders.

ARTICLE 6. A Rule of Public Administration will determine the method of applying the present law.

The following provisions concerning the examination for a certificate of fitness to give instruction in Manual Training, are translated from the French laws relating to public instruction:

ARTICLE 194. Two Commissions, the one for male, the other for female candidates, are appointed each year by the Minister of Public Instruction, who will examine for the certificate of fitness to give instruction in Manual Work.

Two directors or professors, either of the normal school or of a superior primary school, must constitute a part of the Commission appointed to examine candidates.

ARTICLE 195. The candidates are required to enroll themselves in Paris at the Sorbonne, and in the departments at the office of the Inspector of Academie, to indicate the places where they have resided and the duties they have performed for the last ten years, etc.

ARTICLE 196. The register of enrollment is closed one month before the opening of the session. The list of candidates is announced by a Ministerial Order.

ARTICLE 197. The examination consists—for male candidates—first, of a composition of geometrical drawing: elevation of an object in relief, and drawn exactly to a given scale, or of a sketch relating to an elementary problem in descriptive geometry (line and plan, intersection of geometrical solids in simple cases; prisms, pyramids, cylinders, cones and spheres—questions of shade) three hours; second, of a test in modeling after an easy model, with reference to the chief characteristic of the model, four hours; third, of the execution, according to a drawing, of a piece of work in wood or iron, four hours; fourth, of the execution, after a model, of a simple object in wood-turning, three hours.

In the course of the last two trials questions are given to the candidates respecting the raw material placed before them, as well as respecting the processes which they have employed.

For female candidates: First, of a composition upon some question of domestic economy, three hours; second, of a composition in ornamental drawing specially applied to needlework; third, of a practical test relating to one or more of the exercises included in the programme of manual labor for girls in the normal schools and the superior primary schools.

ARTICLE 198. All the compositions are made at Paris in two consecutive days.

ARTICLE 199. After the close of the examination, the Commission arranges, in the

order of merit, a list of the candidates whom it considers worthy of the certificate of fitness to give Manual Instruction.

This list is submitted to the approval of the Minister, who delivers the certificates.

The following resolutions, adopted at an International Congress of Teachers, held at Havre, September, 1885, are believed to express the prevailing sentiment among teachers in Continental Europe :

1. The Congress recognizing that manual training should be made an integral part of a good system of general education, since it contributes to the development of activity, observation, perception and intuition, declares that it should be introduced as well as possible into the primary schools.

2. Manual training should be the same for all schools in the elementary and middle grades; in the complementary and superior courses it should be gradually adapted to local needs.

3. The instruction in manual training in the elementary school should be given directly by the teacher, or, provisionally, under his direction, by workmen—who shall furnish all necessary guarantees of capacity, morality and conduct—who shall be chosen on his recommendation.

4. The Congress, considering that it is important first of all to prepare the future teachers for the new instruction, and to furnish to those who are now teaching a source of information, declares that the regulations in force relative to drawing and to modeling, works in the shop, in the laboratory and the experimental field, should be applied without delay in all normal schools, from which the example and the impulse ought to proceed. Special courses in manual training should be instituted during vacations in the normal schools, for the benefit of teachers who shall make request for them.

5. In girls schools manual instruction should include, besides works in sewing, practical exercises relative to domestic economy, to gardening and to cutting.

6. The superior primary schools should have a provisional character in this sense: that they should do a portion of the manual work with reference to local needs. The practical exercises should include wood-working, iron-working, modeling and the applications of agricultural science in the experimental field.

7. Work-shops should be annexed to all superior primary schools, and to the elementary schools—city and rural. The State should require the municipalties which have created superior primary schools to appropriate as promptly as possible the funds necessary for installing them.

8. Industrial drawing should have a very large place in the schools of apprenticeship, and the superior primary schools. It should have descriptive geometry as its foundation.

9. It is desirable that certain advantages be attached to the possession of the certificate of superior primary studies.

10. The instruction in manual work in the superior primary schools should be intrusted to workmen chosen with care, on the recommendation of the director, and should be placed under his authority. In the superior primary schools for girls, the instruction in cutting should be intrusted to expert work-women, chosen by the teachers and placed under their direction.

11. In important centers schools of apprenticeship should be established similar to that at Havre and adapted to the needs of the locality. They should be founded by the Communes, by the Chamber of Commerce, by Syndical Chambers or by any other associations. Institutions of apprenticeship should be established in each department to receive orphans, children morally abandoned, or incorrigible.

12. The direction of the school of apprenticeship should be single, and confided to the teaching director.

The E'cole Normale Superieure de Travail Manuel*

No. 10, Rue des Ursulines, Paris, has been created for the training of masters, who shall instruct the students of the ordinary normal schools

*This account is taken from the Report of the Royal Commissioners, vol. I, p. 210.

of the country in manual work. It was established and opened on the 1st of December, 1882. The course, as at present arranged, lasts for one year of ten months. It is, however, contemplated that it will be necessary to extend it over a second year eventually, but as the masters are very urgently required, it is necessary to prepare a certain number in the one year for the present.

The students have to pass a qualifying entrance examination, which consists of the Brevet de Capacité, usually required for teachers, and certain extra subjects—chemistry, physics and natural history; they do not require to be qualified in any way in manual work before their admission. The limit of age is from 20 to 35. Although the Brevet de Capacité will eventually be indispensable, the regulations have in this first year been somewhat relaxed.

The school is held in a former girls' school, which has been hastily and temporarily fitted up for its present purpose. It has a considerable area of land at back and front. There are two small botanical gardens, and a graveled court yard serving for recreation and gymnastic exercises. It is intended that the students shall have military training.

There are at present 48 masters in training; this being the full capacity of the establishment. Thirty of these board in the house, the remainder are provided for in the neighborhood.

The cost of fitting up the school has been about £2,400 ($12,000). The instruction is gratuitous. In fact, the students receive payment, as those who are already teachers of primary schools retain their pay while they remain here, and the others receive the sum of £5 ($25) per month. There are seven professors forming the teaching staff, and ten master workmen. The latter are only employed during certain hours, giving such a portion of their time as may be needed. All the work done in the workshops belongs to the students; nothing made is intended for sale. The cost of materials used in the workshops is about £7 4*s.* ($35) per month. It is expected that the budget of the school will amount to £3,600 ($18,000) for the first year of ten months, equal to about £7 10*s.* (about $36.50) per head per month. All the costs of this school are borne by the State, but as it is an experiment only, there is no sum yet taken for it in the budget of estimates.

It will be seen from the programme that the course of instruction is partly theoretical and partly practical. One and a half hours per day are allotted to theoretical work, and 4½ hours to mechanical work in the shops. There is no practicing school attached to this normal school, as is generally the case, but demonstrations are given by each student in turn before the others, in presence of the master. The teaching is uniform, all going through the same stages.

The mornings are as a rule devoted to working in wood, the afternoons to working in iron. Each student makes a set of small models

for his own use for teaching purposes. Modelmaking seems to be a strong feature of the teaching. There is a special modeling room, in which all are taught modeling in clay and subsequently the preparation of plaster models of building construction on a small scale—masonry joints, stone work, etc.; there is a special teacher for this branch of the work, and four hours per week are devoted to it. We were shown some very neat plaster models of arches, made to a scale of one-tenth full size, careful drawings of which had first been prepared.

The fitting shop contains 24 vises. All the students learn to file and to chip. There is a regular set course of work lasting four months. Places are provided in the smithy for 6 students, who learn forging and welding, making up bars from faggots of scraps, making nuts and bolts, etc. Six work simultaneously at the iron lathes in the turning shop, and 12 at the wood lathes. There are two foremen workmen in each of the shops, with the exception of the turnery, where there are three. The students pass two months at wood turning and two months at iron turning. There is no power provided for the lathes, as none could be obtained in the schools to which the teachers would eventually be sent.

The natural history teaching is also made a special and prominent feature in this school. There are two professors in this department. The professor of botany gives lectures in his subject, illustrated partly by the specimens in the botanical garden, and partly by the excursions, which take place every fortnight. There is also a physiological laboratory, which contains a large collection of aquaria, together with toads, and tortoises in tanks; also many other living animals, rabbits, rats, squirrels, etc. These are not used for purposes of vivisection, but for simple anatomical lectures, for stuffing, etc.

There is a well fitted laboratory, in which all the students learn photography. They are specially taught how to prepare negatives suitable for screen projection, as this is regarded as an important mode of illustrating lectures on natural history.

A geological collection is being formed by the students, who go out on an excursion in the neighborhood of Paris once every fortnight on a weekday during the summer, and also on Sunday afternoons.

On the upper floor of the school is a series of rooms, where the students prepare their studies. Here we were shown a small collection of woodwork, made in the Swedish Slöjd schools, and collected and presented by the director, M. Salicis. In another room were hung numerous satchels and tin botanizing boxes, butterfly nets, geological hammers, etc., for the excursions previously described. This apparatus was all numbered, and is lent to each student during the time he remains at the school. Here was also a collection of diagrams of simple dissections used by the professor of physiology.

On the first floor was a school museum and lecture theatre; on the

ground floor a refectory, where the students and masters take their meals together. There is a very cleverly fitted chemical laboratory, the professor being the former chemistry master at the Professional School of Rheims. This laboratory, which occupies an area of only 550 square feet, contains working places for 48 students. The benches are covered with white glazed tiles, and provide a metre in length for each student. The sets of re-agent bottles had India-rubber stoppers with pipettes passing through them, thus enabling the student to use at will either a very small or a larger quantity of the re-agent. The professor explained his system of chemical work to be one of regular drill, all the students performing a series of set experiments simultaneously; he having a raised desk, from which he could overlook the whole of the work in progress, and see that each man was carrying out his experiment properly.

The sub-director, M. Merceaux, informed us that it was not proposed, so far as he knew, to establish schools for training master-workmen to serve as instructors in primary schools; such men could, doubtless, be readily obtained from the Arts and Trades Schools at Aix, Angers and Chalons. Several of the masters at this school have come from the Ecole des Arts et Metiers at Angers.

The students, whether living in the house or lodging in the neighborhood, are all free after 6 o'clock. No masters have as yet issued from the school, as a full year has not yet expired since its establishment, but M. Merceaux stated that he thought that some of the men then in training would be perfectly competent to undertake the duties for which they were being prepared at the expiration of the pre-arranged course. He stated that there was considerable inducement to masters to exchange a career of teacher in a primary school for that for which they were here trained, as the salary of a professor at a normal school was approximately double that of an ordinary primary school teacher."

Normal Schools.

The following tables show the distribution of subjects of instruction by years and by courses in Normal Schools for male and female teachers, respectively :

1. For Males.

SUBJECTS.	TOTAL HOURS PER WEEK.		
	First Year.	Second Year.	Third Year.
Civic Instruction,	......	....	1
Morals,	2	2	......
Pedagogics and School Administration,	1	1	1
The French Language and Elements of French Literature,	7	5	4
History,	4	3	3
Geography,	1	1	1
Arithmetic and Book-keeping,	2	3	3
Geometry, Surveying and Levelling,	1	2	3
Physics,	1	2	2
Chemistry,	1	1	1
Natural Sciences,	1	1	2
Agriculture and Horticulture,	....	1	1
Living Languages,	2	2	2
Writing,	2	1	....
Drawing,	4	4	4
Singing and Music,	2	2	2
Gymnastics and Military Exercises,	3	3	3
Agricultural and Manual Work,	4	4	4
Total,	38	38	37

2. For Females.

SUBJECTS.	TOTAL HOURS PER WEEK.		
	First Year.	Second Year.	Third Year.
Moral and Civic Instruction,	1	1	1
Pedagogics and School Administration,	1	1	1
French Language and Elements of French Literature,	6	5	4
History,	4	3	3
Geography,	1	1	1
Arithmetic and Book-keeping,	3	3	3
Physics,	....	1	1
Chemistry,	....	1	1
Natural Sciences,	1	2	2
Domestic Economy and Hygiene,	....	1	1
Living Languages,	2	2	2
Writing,	3	1	......
Exercises in Cutting,	3	3	3
Drawing,	4	4	4
Singing and Music,	2	2	2
Gymnastics,	2	2	2
Floriculture and Gardening,	2	2	2
Total,	35	35	33

The great storehouse of testimony respecting the whole subject of technical education are the volumes containing the results of the inquiries of the British Royal Commission. We give here a few extracts, relating to detached but important subjects:

Women's Work Schools in France.

Municipal Housekeeping School, Paris.—This school, known as the *Ecole Professionnelle Menagere*, is situated in the Rue Violet, 36, and has been open since the 1st of May, 1881. Its aim is to offer to young girls leaving the primary school the opportunity of learning some useful trade, and of giving them at the same time experience in domestic duties and household work, thus preparing them to carry on the avocations of family life. The ordinary subjects of primary education are taught during the morning. This training serves to keep up and to strengthen the knowledge of the pupils acquired in the primary school. The special technical classes comprise a general course obligatory for all the pupils, and special technical courses suited to the profession or business which the pupil may have chosen.

The conditions with respect to admission are as follows: For entering the professional and housekeeping classes the girls must be at least 12 years old, and must not exceed the age of 15, and they must hold the certificate of primary instruction. As a temporary expedient, however, dispensations are granted to children who are at least 13 years of age, and who know how to read and write.

The school is under the direction of Madam Lajotte and a staff of teachers for needlework, seamstresses' work, fine washing, embroidery on stuffs, artificial flowermaking and staymaking. There are also special teachers for the subjects of primary instruction, for cutting out and making up dresses, as well as for gymnastics, housekeeping, cooking, washing, ironing, etc. The pupils receive a premium proportionate to the value of the work done by them, when this work is of such a nature as to be capable of being used.

Of the trades taught, ordinary dressmaking for the working and lower middle classes appears to be the one for which there is the greatest demand. Next to this millinery and laundry work. The least profitable is said to be artificial flowermaking. All the girls take their turn at household work, including cooking.

The municipalty of Paris propose to extend this school, which is situated in a quarter of the city inhabited almost exclusively by the working classes, and to establish other schools of the same kind in other similar parts of Paris.

Engineering Works of Messrs. Schneider & Co., Le Creuzot, France.

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A very small number of the heads of departments are former students of the great Parisian technical schools, several are from the E'cole des Arts et Mêtiers, and many, including nearly all the foremen, have received no other instruction than that of the works and the excellent elementary schools founded and maintained by the firm. The head of the drawing office is one of these latter. The opinion of Mons. Henri Schneider was not favorable to the very high scientific courses of the Paris schools, except for men of remarkable ability, and of the energy and common sense necessary to acquire workshop practice at a comparatively late period of life, and to avoid a pedantic application of abstruse theory to practical work. His estimate of the E coles des Arts et Mêtiers, on the other hand, was very favorable. In several cases the firm had sent promising boys to those schools; but the workshop was held to be the true school for foremen.

In the elementary schools connected with the works and carried on at the expense of the Company, great attention is given to geometrical drawing, and the work of the boys was surprisingly good. The elements of chemistry and physics are also taught. Night classes have been given up, partly because the instruction of the elementary day school was considered sufficient, and partly in consequence of difficulties between masters and men during the times immediately preceding, and succeeding to, the fall of the Empire.

Silk Industry—Lyons.

As to the prospects of England ever becoming a formidable competitor in the silk industry, one of the prominent citizens, who seemed to be very familiar with England, ridiculed the idea as being chimerical. He said, "The silk trade can never become important in England, because the English people have no taste. Taste is not natural to the Englishman, and never will be; your sunless climate, your

smoky atmosphere, your absence of art associations and surroundings, are all against the inculcation of taste." "In France," he continued, "everything is different; taste seems to be inborn in the Frenchman, and it is cultivated at every step. You English are a remarkable people, and you take the lead in many things, but in taste you are far behind, and must be content to remain so." Stress was laid on the fact that in France all the children learn drawing as a part of their elementary education, and that the opportunities of continuing their instruction in art are infinitely greater and more generally taken advantage of than in England, and that in one school in Lyons (the Martinière) we might have counted a class of over 90 engaged in modeling. The question was put, "Suppose the order of things were reversed—that drawing and modeling should be taught as meagrely in France as in England—in effect, that they should be banished from most of the elementary schools; and that their extensive and general study as now found in France should be adopted in England, what would you say of English and French taste then?" Our friend replied that he was not prepared to say what would happen under improved teaching of art in England, but to banish such teaching from the elementary schools of France would be nothing less than a national calamity.

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An English merchant, long resident in Lyons, informed us that when the Swiss entered seriously into competion with Lyons, they were unsuccessful at first in their dyeing operations, and were compelled to send their yarns and pieces to Lyons to be dyed. The people at that time, as now, boasted of their incomparable water; but the enterprising Swiss manufacturers were not to be easily daunted; they engaged some dyers from Lyons, and they brought to bear upon the question the scientific knowledge of their polytechnic schools; and now, remarked our informant, in many respects they surpass Lyons in dyeing, as they do also in some branches of weaving.

Designing for Textile Industries and Calico-Printing.

The designers for textiles and printed fabrics in Paris form a special profession, having their trade organizations, agencies, their studios, and their system of apprenticeship; by arrangement with the English manufacturers patterns are sent to them for inspection or choice. Sometimes an English firm has even established an "atêlier" in Paris, so convinced have our calico-printers hitherto been that for the highest class of their goods Parisian taste and skill are essential conditions.

"A good designer in Paris may earn from £250 to £300 ($1,250 to $1,500) a year, and the most distinguished, even considerably more than this, but, as in other trades, it is often found hard to earn a living.

"Apprentices are taken by the Paris designers, beginning at about 5*s.* ($1.25) a week; they are required to practice model drawing and are encouraged to attend the evening drawing schools, care being taken to insist upon their working from natural objects such as flowers and foliage."

Technical Education Amongst the Alsace Calico-Printers.

From our own observation, as well as from the evidence given before us by Mr. Haeffely, there is no doubt that a greater amount of scientific and especially of chemical knowledge exists in foreign calico-print works than in those of this country (see page 1 of evidence). The Alsace managers are invariably trained chemists, and a special profession, that of colorist chemist, exists on the Continent, which has not yet obtained a firm footing in our own country. The necessity for supplanting the rule of thumb processes and pretended secrets of the old-fashioned color-mixer, by scientific knowledge of the materials with which they deal and of the reactions which they employ, is now becoming felt by all the better class of English calico-printers, and in many of these establishments at the present time technically trained and competent young men are found. Equal opportunities for the study of this branch of applied science exist at the present time in England to those found on the Continent, and there is no reason why the colorist chemist trained in Eng-

land should not become as efficient as the one educated in Alsace, so soon as the demand for, and the appreciation of his services is as great with us as it is abroad.

Engineering and Machine-making Works, Alsace.

The director of the works informed us that they take great pains to select educated boys as apprentices. Most of them have gone through the Professional School at Mulhouse, and have there learned the use of tools, obtaining in many instances an excellent preliminary training in theoretical engineering. They give a decided preference to boys from this school. The foreman who conducted us over the works, himself a student from the polytechnic at Zurich, confirmed the statement.

Time Table of the E'cole d'Arts et Metiers at Chalons-sur-Marne.

Division.	Hours.		Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Sunday.
			Rise at 5.30.						Rise at 6.30.
1.	Morning.	6 to 7¼.	Preparation.	Preparation for Chemistry or Physics.	Preparation. Grammar.	Questions in Grammar.	Preparation.	Preparation. Grammar.	Dressing, Recreation, Breakfast Review. Mass at 8.00 o'clock.
		7¼ " 7¾.	Breakfast and short interval for recreation for all the three Divisions, except on Sunday.						
		7¾ " 9.	Chemistry or Physics.	Mechanics.	Preparation.	Mechanics.	Chemistry or Physics.	Mechanics.	
		9 " 12.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	From 8.45 to 10.00, Recreation and Library.
		12 " 1½.	Dinner and interval for recreation for all the three Divisions daily, except on Sunday.						
	Afternoon.	1½ " 3.	Drawing.	Drawing.	Drawing.	Drawing.	Drawing.	Drawing.	From 10.00 to 12.00, Preparation for all the Three Divisions.
		3 " 3¼.			Religious Instruction.				
		3 " 6¾.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	
		7 " 7¼.	Supper and short interval for recreation for all the three Divisions daily, except on Sunday.						
		7¼ " 8¾.	Grammar.	Preparation for Mechanics.	Grammar.	Preparation for Mechanics.	Preparation for Chemistry or Physics.	Preparation for Mechanics.	From 12.00 to 1.30, Dinner and Interval for Recreation.
2.	Morning.	6 to 7¼.	Grammar.	Preparation.	Questions in Grammar.	Preparation.	Grammar.	Preparation.	
		7¾ " 9.	Mathematics.	Account keeping { Preparation.	Mathematics.	Chemistry or Physics.	Mathematics.	Account keeping. { Preparation.	From 1.30 to 2.00, Dressing and Preparing for Walk.
		9 " 12.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	
	Afternoon.	1½ " 3.	Drawing.	Drawing.	Drawing.	Drawing.	Drawing.	Drawing.	At 2.00, Walk or Free Time for Study.
		3 " 3¼.			Religious Instruction.				
		3 " 6¾.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	
		7¼ " 8¾.	Preparation for Mathematics.	Preparation for Grammar.	Preparation for Mathematics.	Preparation for Chemistry or Physics.	Preparation for Mathematics.	Preparation for Grammar.	At 6.00, Supper.
3.	Morning.	6 to 7¼.	Preparation.	Questions in Grammar.	Preparation	Grammar.	Preparation.	Preparation for Grammar.	From 6.30 to 700, Recreation.
		7¾ " 9.	Preparation. { Account keeping.	Grammar.	Preparation.	Mathematics.	Account keeping. { Preparation.	Mathematics.	
		9 " 12.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	From 7.00 to 8.00, Free Time for Study.
			NOTE.—Questions are asked daily during the work time in the shops from 9.15 to 10.45.						
	Afternoon.	1½ " 3.	Drawing.	Drawing.	Drawing.	Drawing.	Drawing.	Drawing.	
		3 " 3¼.			Religious Instruction.				
		3 " 6¾.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	Workshops.	Bed { First half year at 8.00. Second half year at 8.30.
		7¼ " 8¾.	Preparation for Grammar.	Preparation for Mathematics.	Preparation for Grammar.	Preparation for Mathematics.	Preparation for Mathematics.	Preparation for Mathematics	
			Bed at 8.45.						

Higher Technical Instruction for Employers, Managers, Etc.

The Ecole Centrale des Arts et Manufactures of Paris.

This important and well-known institution is designed to prepare students for the professions of civil and mechanical engineering, metallurgy and manufacturing chemistry. It was founded in the year 1826, chiefly through the interest of M. Dumas, (whose recent death science has to deplore), and is essentially a private and self-supporting establishment, not receiving any grant from Government, and depending entirely on the fees of the pupils, thus standing in striking contrast to other similar institutions on the continent. It has, however, lately been attached to the Ministry of Agriculture and Commerce. The annual receipts amount to £20,640 ($103,200), and the disbursements to about £17,836 ($89,180), the difference being paid over to the new building fund. The school is at present located in an old building in the Rue des Coutures St. Gervais, totally inadequate to its needs, but it is shortly to be transferred to splendid premises about to be built near the Conservatoire des Arts et Metiers, chiefly at the Government expense, though partly also at that of the school.

There is a very strict entrance examination and great competition for the vacant places; of the 540 candidates who applied in the year 1881 only 220 were admitted. None of the students are boarded in the establishment.

The regular course extends over three years, and diplomas are given to the students at the end of the course, after passing a very severe examination and working out a thesis. A strict system of continuous examination and marking is carried out, the work which each student does being entered carefully by each examiner, and the results of the whole three years' work are added up; the special grade of the diploma being given according to the result of this system of marking.

The first year's course consists of instruction in general science, without much applied science, and is similar to that given in the E cole Polytechnic, whilst in the second and third years the teaching is especially directed to applied science, and is similar to that given in the E'cole des Mines. The later instruction has special reference to the practical applications of each subject. The student who fails to gain his diploma at the end of the third year, may pass the examination without re-entering the school, at any period within six years after leaving the institution.

The peculiarity of the education of this school is, that the instruction is much the same for all students, and that there is scarcely any

specialization of the studies in accordance with the proposed career of the student. The difference is mainly shown, as hereafter explained, in the thesis or "*projet*" which the student prepares during the last year.

Each of the 600 students pays £32 ($160) per year, and the governing body of the school manages the whole of its financial and other concerns. There are 30 professors attached to the institution, the chiefs of departments receiving £300 ($1,500) per annum, the others £4 ($20) for each hour of lecture. In addition there are two directors of studies and 30 tutors and assistant lecturers. The students on leaving the school, and after having gone through its very severe discipline, are glad to get situations of £72 to £80 ($360 to $400) per year. The Director, M. Solignac (whose salary is $2,000 per annum), furnished the Commissioners with a list of the present positions of all the pupils since the beginning of the school.* A large number of manufacturers send their sons to the E'cole Centrale.

One of the most interesting features in the scheme of education in the E'cole Centrale is the system of theses, which are written by the students at the end of the third year. The courses of instruction on which these theses are founded are divided into mechanics, metallurgy, technical chemistry and engineering. Each student takes up one or other of these subjects for his thesis, as he deems fit, although the three years' course of instruction is not confined to any one of these branches, but comprises the subjects of all. The Commissioners inspected several of the theses of the outgoing students of former years, in each of the above departments, and were much struck with the detailed character of the work, and especially with the completeness of the drawings. The students are allowed to work at home, but have to produce the calculations, descriptions and drawings, within one month from the time at which the subject is given out, and the whole work is carefully examined by a council of professors, the student being examined on the details of his thesis.

Programme of the E'cole Centrale des Arts etManufactures, Paris.

First Year.

	Number of Lessons.
Mathematical Analysis (Differential and Intergral Calculus),	30
Kinematics and General Mechanics,	52
Descriptive Geometry,	60
General Physics (Heat, Electricity, Magnetism, Acoustics and Optics),	60
General Chemistry (Metalloids, Metals and Organic Substances),	60
Mineralogy and Geology,	30

*See the Annual of the Friendly Association of Old Students of the School from 1832-1880, published by the Association at the E'cole Centrale in the Rue des Coutures St. Gervais, giving an account of the employment and position of all the old pupils of the school.

	Number of Lessons.
Biology (Zoology and Botany),	35
Machine Construction,	20
Architecture,	24

Second Year.

Applied Mechanics (Theory),	60
Applied Mechanics of Construction (Resistance Appliquee),	22
Construction and erection of machinery,	52
Industrial Physics (Heat, Gas, Ventilation),	45
Principles of the Steam Engine,	35
Analytical Chemistry,	50
Technology (Metals, Colours and Dyes, Pottery and Glass),	36
Mining (1st part),	25
Civil Architecture and Construction,	54
Zootechny,	26
Phytotechny,	20
Industrial Legislation,	30

Third Year.

Applied Mechanics,	60
Construction and Erection of Machinery,	55
Industrial Chemistry,	45
General Metallurgy and the Metallurgy of Iron,	52 to 55
Mining (2d part),	15
Public Works,	60
Railways,	60
Rural Economy,	40

NOTE.—During each year the pupils have to prepare designs and drawings, and to work in the laboratory under the guidance of the professors.

II. GERMANY.

It has seemed to the Commission that the space at its disposal for this and some other countries could be most profitably used by presenting extracts from the report of the British Royal Commission, covering a number of the most important points of inquiry, without regard to a systematic order, but all bearing upon the double question of methods and results. For the sake of avoiding the annoyance of frequent breaks in the text, separate passages have been brought together, but in no case, it is believed, in such a way as to color a statement of fact or opinion as presented by the Royal Commission.

(a) Polytechnic Schools or Technical Universities of Germany, etc.

The great impulse which was given to engineering and manufactures some 40 or 50 years ago by the formation of railways and the establishment of factories throughout Europe, and the demand which arose for highly skilled assistants, owing to the widespread introduction of the steam engine and other mechanical inventions depending upon it, gave rise in Germany and Switzerland to the creation of High Schools, in which the necessary scientific training with its practical applications could be imparted, so that by this means a body of men might be educated in such a way as to make it possible for Continental states to compete with the work-shop-trained engineers of England.

The numerous Universities of Germany did not furnish instruction of a sufficiently practical character, nor were their authorities willing to admit within their walls a class of men who would be likely to devote themselves especially to industrial pursuits; nor, again, would they lower or alter the standard required from University students on entrance, as ascertained by the "leaving examination" of the classical school. Moreover, they did not care to permit any system of fixed curricula and examinations in lieu of their accustomed plan of *Lehr und Lern Freiheit.* It must also be remembered, moreover, that at this time the practical teaching, even of the pure physical sciences, was only in its infancy in the university.

The requirements for instruction adapted to the necessities of the time became so urgent that each State vied with the others in the extent and magnificence of its buildings for Polytechnic Schools, as as also in the grants voted for the maintenance of those institutions.

The following is a list of the principal schools:

(1.) The Federal Polytechnic School of Zurich.*

(2.) The Polytechnic School at Munich.

(3.) The Polytechnic School at Vienna.

* Another term for "Polytechnic" is Technical High School, which is equivalent in English to Technical University.

(4.) The Polytechnic School at Stuttgart.
(5.) The Polytechnic School at Dresden.
(6.) The Polytechnic School at Hanover.
(7.) The Polytechnic School at Carlsruhe.
(8.) The Polytechnic School at Aachen (Aix-la-Chapelle).
(9.) The Technical High School of Berlin (for which a new building is now in course of erection at Charlottenburg).
(10.) The Polytechnic School, Delft.
(11.) The Polytechnic School of Moscow.

These schools have been built at a cost of not less than three millions sterling ($15,000,000), and are maintained at an annual cost of over £200,000 ($1,000,000).

We proceed to give a few particulars respecting these institutions, all of which, with the exception of that at Moscow, have been visited by the Commissioners.

(1.) *The Zurich Polytechnic School.*—The Federal Polytechnic School of Zurich, which is one of the largest as well as one of the most successful of its kind, was established by the Swiss Confederation in 1854, and the building has since been considerably enlarged and extended. This noble edifice forms one of the principal features of Zurich, standing on a commanding eminence above the city. The institution comprises seven special schools:

(1.) The architectural school, with 3 years' course.
(2.) The civil engineering school, with 3½ years' course.
(3.) The mechanical engineering school, with 3 years' course.
(4.) The school of chemical technology (including pharmacy), with 3 years' course.
(5.) The school of agriculture and forestry, forming two sub-sections, with a course of 2½ years.
(6.) The normal school, destined to educate special teachers for mathematics and natural science, also forming two sub-sections.
(7.) School of philosophical and political science.

In addition to these, there is a preparatory mathematical course, for those students who are not able to pass the entrance examination required in this subject, to admit them to any one of the above courses.

* * * * * * * * *

To give an idea of the completeness and extent of this institution, it will be sufficient to state that there are upwards of 200 distinct courses of lectures, given by 45 professors and 13 assistants, not counting the tutors, the curators of the museums, and the servants employed in the establishment.

Many names, well known in science and literature, have been in the past, or are at present connected with this great institution.

The budget of the school for 1876 was as follows:

Annual federal subvention, ...	£13,880
Annual subvention of the canton of Zurich, ...	640
Subvention of the canton and the town of Zurich for the purposes of the natural history collection, ...	176
Fees paid by students, ...	3,794

The total annual expenditure being a little under £20,000 ($92,-450).

In addition to this a considerable sum has been bequeathed to the institution, amounting to a total of nearly £20,000 ($100,000), and within the last few months, a sum of £50,000 (about $250,000), has been voted by the Federal Council for the extension of the chemical laboratories.

The regular students must have attaied the age of 18, and must either produce certificates of good conduct, and of having passed through the necessary preliminary studies, or must undergo an entrance examination, producing specimens of their own drawing. There were in the winter semester of the year 1880–81, 488 students and 253 auditors, total, 741; and in the year 1881–82, the total number was 685.

For a complete course of instruction in any one department the fee is £4 ($20) for the semester. The winter semester lasts from October to March, and the summer semester from April to August. In addition, £2 ($10) is charged for each of the laboratories in the winter semester and £1 16*s*. (about $9) in the summer. Thus the total cost to a student in the chemical department, including laboratory practice, does not exceed £12 (about $60) per annum.

The Department of civil engineering at the Zurich Polytechnic, is one of the most important in the school, and was founded in the year 1855, together with the schools of mechanical engineering and chemistry.

The course of instruction extends over a period of three and a half years (seven sessions), and begins each year in October.

For admission to this Department the candidate has to pass an examination in mathematics, mechanics, physics and drawing, or to show certificates from a former school that he possesses the required proficiency in these subjects. Intending students may enter either as regular students (Schüler) or as auditors (Zuhörer). The former are bound to attend all the obligatory courses of lectures, and pay £4 ($20) as a fee for the whole year; auditors can obtain permission from the professors to attend the courses they wish, and pay a fee of four shillings (about $1) a session for each lecture or hour's drawing they attend in a week. The great difference in the expense makes the number of auditors very small.

The first three sessions are occupied almost entirely with theoretical subjects, such as pure mathematics (differential and integral calculus, differential equations, and higher analytical geometry), descriptive

geometry, with drawing, mechanics and physics treated mathematically. These subjects are attended also by the students of the Mathematical School, and are, in the opinion of some, rather too exhaustively treated for students of engineering. For instance, the descriptive geometry course extends over three sessions, with three or four lectures a week, and includes four hours' obligatory drawing per week for the first two sessions. The four hours' drawing per week is insufficient to finish the problems given, and often 15 to 20 hours in a week have to be spent in solving problems in descriptive geometry. The theories expounded in the third session are of a still more advanced character.

Besides these subjects there are in the first three sessions several short courses on more practical subjects, *e. g.*, elementary architecture, petrology, applied geology, chemistry of building materials, and surveying and surveying instruments.

In the fourth session the lectures on geopraphical statics are commenced, a knowledge of which is very important in bridge-designing. The system of teaching statics mainly by geometrical construction has hitherto been little employed in England and France in practical designing, but it is well known in Germany and Italy.

The last two years of the course include lectures on various branches of engineering, tunnels, stone and iron bridges, railways, canals, roads, geodesy, etc., besides a great amount of drawing and designing in these subjects. There are also courses of practical surveying, and astronomy, with observatory practice.

In all the subjects there are from time to time, usually weekly, short *viva voce* examinations, and problems are set to be solved out of hours, so that the system of teaching is very thorough. Diplomas of proficiency are given to students who pass the special examinations held at the end of the fourth and seventh sessions.

The average number of students in civil engineering is about 110, and is a great falling-off from the number in the years 1870–77, which averaged about 260. The fact that the number of non-Swiss students is about 70 per cent. of the whole is a proof of the wide-spread reputation of the school. The foreigners are from all parts of Europe, especially Austria and Hungary, as well as from North and South America (Brazil).

An important feature of the institution is the number and variety of the laboratories, libraries, museums and collections of apparatus and objects of scientific and artistic interest, which the institution possesses, of which the following is a list:

1. Several libraries—(*a*) belonging to the school, (*b*) to the canton and (*c*) to the town of Zurich. These latter have been placed at the service of the students.
2. Various collections belonging to the engineering and architectural divisions, consisting of models, instruments, etc.

3. A collection of plaster casts of architectural ornaments.
4. A collection of specimens of construction and of materials used in building.
5. A collection of antique vases.
6. A collection of engravings, about 24,000 in number.
7. A collection of geometrical instruments.
8. A collection of models of machinery.
9. A collection of tools and models for the section of applied mechanical technology.
10. A collection of models and raw and finished products for the section of chemical technology.
11. A collection of mathematical and geometrical models.
12. A collection of interesting specimens, tools, etc., relating to forestry.
13. A collection of models, implements and produce in all departments of agriculture.
14. Collections of specimens relating to natural history, zoology, botany, mineralogy, geology, palaeontology and entomology.
15. An archaeological collection.
16. A workshop for molding and casting in clay and plaster.
17. A workshop for metal work.
18. Laboratories for instruction in theoretical and applied chemistry.
19. A special laboratory for agricultural chemistry.
20. A cabinet of physical apparatus and a physical laboratory.
21. An institute of vegetable physiology, comprising a room for microscopic researches, a physiological laboratory, botanical collections and hothouses.
22. A botanical garden, with a museum for the general and botanical collections.

In common with the Polytechnic Schools of Germany, there is no manual instruction in workmanship of a mechanical character.

The practical instruction in each department is of a strictly scientific nature. Thus, for example in chemistry, the instruction given in Prof. Victor Meyer's laboratory is identical with that given in the University laboratories of Germany. But after passing through the course of pure chemistry, including both laboratory practice and lectures, the student may proceed to the classes and laboratory work of the professor of applied chemistry, Dr. Lunge; the practical work consisting chiefly in the preparation of chemical products. The laboratories both of physics and of chemistry are antiquated, and are altogether insufficient for the present requirements of the students. Large extensions in this respect are about to be made, the sums voted for this purpose amounting, as already stated, to £50,000 ($250,000).

The remark which has been made with regard to chemistry applies also to the physical teaching, namely, that the instruction is not specially adapted to any particular industrial work, but is of a general

and purely scientific character. In some of the Polytechnic Schools, notably in Munich and in Stuttgart, practical laboratory instruction in physics has only been recently introduced, and as yet on a small scale: even in these cases the instruction is strictly scientific and is not especially adapted to any branch of electrical engineering, or to any other industry to which a knowledge of physics might be applied. In Dr. Weber's physical laboratory at Zurich, it is true, a small number of students receive practical instruction in exact electrical measurements, in testing of resistances, etc., but no courses of a technical character have at present been introduced into this department of the Polytechnic.

This renowned school has from its very commencement endeavored to impart the greatest possible extent of scientific instruction in each of its departments, and its efforts have been to direct thought and research of the highest kind in their applications to industrial pursuits, and thus to bring about the necessary mutual interchange of ideas between science and practice; and it has been so far sucessful that students have come to it from all parts of the world. The Commissioners had the opportunity of judging of the advantages which it has bestowed, not only upon Switzerland, but also upon Germany, by the number of thoroughly trained scientific men who have been educated within its walls and who are now holding important positions in various industrial establishments which the Commissioners have visited.

(b) Report on Technical Training in Prussia, by Herr Von Puttkammer.

The following is a resumé of a Report on the Organization of Technical Instruction in Prussia, prepared for the British Commission by Herr von Puttkammer.

In the first place, it appears that no system has yet been developed for the technical instruction of foremen and workmen in Prussia. Such arrangements as exist, differ in various places, and cannot be regarded as permanent. Indeed it may be said that by far the larger proportion of skilled artisans, foremen and operatives in Prussia have no opportunity afforded them, and, it may be added, often exhibit no desire to obtain further information than they have gained in the primary school, where the instruction in drawing, of such special importance to the future artisan, has hitherto not received the attention it deserves. An improvement in this direction is contemplated, but its execution will be tedious and costly.

Secondly, the technical education of the persons intending to become masters and managers of industrial establishments has been placed in Prussia on a systematic basis. This is especially the case

for the subjects of mechanical and civil engineering, chemistry and architecture, and for this purpose, technical high schools of Berlin, Hanover and Aachen have been established, the cost of these establishments being borne solely by the State. All persons employed in the Civil Service in the branches of engineering or architecture are obliged to attend one or other of the above schools, and are required to pass examinations in the several courses of study, whilst entrance to the technical high schools is allowed only to those who can present the leaving certificate from a gymnasium, Real gymnasium, or an upper Real school, indicating the proper completion of a strict preliminary training.

Side by side with this advanced system of technical instruction in Prussia, a number of "Real" and "Trade" schools exist. These perform the functions of giving a training of a less advanced type available for persons in the position of sub-managers, or for students of secondary rank. The higher class of these schools are called upper real schools, and include a course of instruction spread over nine years; others, of a somewhat lower type, have courses lasting for six or seven years; these latter are termed burgher schools, and in them a general education is given. For carrying on the technical training of pupils from these, or from the primary schools, or of persons already apprenticed or engaged in trade, a class of schools known as "trade schools" (Fachschulen) exists. The number of these institutions in Prussia is but small, and efforts recently made for their increase and improvement have not been so successful as might be wished, the reason being that the locality is obliged to defray the cost of buildings, and half the annual expenses not covered by school fees. The fact that the total annual cost to the State of these schools does not exceed £18,000 ($90,000) proves that they can neither be numerous or of an elaborate character.

The technical schools proper of Prussia include the following:

(*a.*) Eight building schools in Berlin, Nieuberg, Eikernförde, Breslau, Höxter and Idstein.
(*b.*) One school for machine construction at Einbeck.
(*c.*) Four weaving schools at Crefeld, Mulheim and Einbeck.
(*d.*) A training school for basket makers at Heinsberg.
(*e.*) A trade school for pottery at Höhr.
(*f.*) A trade school for workers in metal at Iserlohn and another at Remsheid.

In addition to these special schools, about 10 or 12 trade drawing schools exist in various towns, as well as trade continuation schools for apprentices and artisans under 18 years of age, who can, by local enactment, be compelled to attend these schools, their employers being bound to grant them the necessary time, and attendance at such obligatory schools is recognized by the State. In cases where the obligatory attendance is enforced, the State pays half the expenses,

but the total yearly amount of State grant is not more than £8,000 ($40,000). The most recent additions to this class of school are the artisan school in Berlin, and the Sunday and evening school at Breslau. In neither of these, however, is the attendance compulsory, and the number of pupils in the classes last winter was 700 and 400 respectively.

Other more special technical institutions are the agricultural schools, the educational workshops of the State Railways, the navigation schools and the higher mining schools. Each of these sets of schools is placed under the direction of the Departmental Ministry. Of 561 apprentices in the government railway workshops, 277 attended the special schools established for their benefit. Of the navigation schools about 14 exist. They provide a suitable training for persons entering the merchant service, assisting them in obtaining the knowledge requisite for passing the prescribed examinations for steersmen. No schools for the education of mates or petty officers exist in Prussia. Seven mining schools proper exist in Prussia, viz: in Tarnowitz, Eisleben, Bochum, Siegen, Dillenberg, Saarbrücken and Clausthal, whilst five preparatory or inferior schools for a lower grade of miners are established in the mining centres.

A Royal Commission on technical instruction in Prussia is now sitting for the purpose of receiving communications on the development of the opportunities for technical instruction.

(c) General Review of Polytechnic Schools.

Having concluded our report on the Polytechnic schools of Germany, we pass to certain important general considerations respecting the higher scientific and technical education in that country. In the first place, the question as to the value of the training at the Polytechnic school, as compared with that given at the University, and especially as to how far the division into purely scientific subjects as taught in the Universities, and applied science as taught in the Polytechnic Schools of Germany, is a wise or advisable arrangement, as also of what is the best preliminary training for Polytechnic students, has been the subject of much discussion, and the Commissioners have been at the pains of obtaining opinions on this subject from a number of distinguished men connected with the Universities and also with the Polytechnics.

It may be mentioned that in the Polytechnics of Germany there is accommodation for about 6,000 students, whilst the total attendance is little more than 2,000, and the annual cost to the State of each student, exclusive of interest on capital, is about £100 ($500). This apparently unnecessary extension of the Polytechnic schools in that

country is partially accounted for by the fact that, when they were originally erected, Germany consisted of several independent states which have since been united in the German Empire.

To the multiplication of these Polytechnics, and to the small cost of a higher or University education, may be ascribed the general diffusion of a high scientific knowledge in Germany, its appreciation by all classes of persons, and the adequate supply of men competent, so far as theory is concerned, to take the place of managers and superintendents of industrial works, as well as of teachers in technical and other schools.

In England there is still a great want of this last class of persons; and whether schools of practical and applied science be affiliated to the University, or exist separately and independently as in other countries, it is very important that facilities should be offered to such selected pupils from schools of lower grade as may be competent to profit by it, to receive the highest scientific and technical instruction, gratuitously, or at a small cost, in order that this country may be better supplied than it is at present with competent instructors.

As regards the kind of training that will best fit a youth to become the head of an industrial concern, opinions both here and abroad differ considerably; but in the value of the education given in the German Polytechnics as a part of the training of engineers, most competent authorities on the Continent appear to agree.

In dealing with the superior education of those destined to become employers or proprietors of large industrial concerns in Germany and Switzerland, we must state in conclusion that the Gymnasia and Universities, in spite of the existence of the numerous Techninal High Schools, still serve to train probably the larger portion of those who are to take the lead in manufacturing industries, and that, consequently, the persons so educated cannot be said to receive any technical training in the school. The University is the natural termination of the career of the student entering the Gymnasium, which is *par excellence* the school of the higher and upper middle ranks of society on the Continent; and, where time and money are of secondary importance, no education is deemed to have been properly completed without a few years passed at one or other of the numerous Universities.

There are in all four and twenty Universities in the German Empire, five in Switzerland, nine in Austria, and the German University of Dorpat in Russia, and the total number of students who are being trained in them is little short of 35,000. In the first rank, as regards the number of those under instruction, stands the University of Berlin with the enormous total of 4,995 students, together with 3,900 non-matriculated auditors. Leipsic comes second, with a total of 3,166 students and 3,111 auditors, while Munich has respectively 2,049 students and 2,017 auditors. In the next class are the important and

flourishing Universities of Breslau, 1,682 students; Halle, 1,414 students; Tübingen, 1,414; Bonn, 1,102; Göttingen, 1,096, and Würzburg, 1,091, while the Russian University of Dorpat numbers 1,277 students, and the Austrian University of Lemberg is returned at 1,011. The numbers at Vienna and Pesth are not stated, but they probably considerably exceed those at Lemberg. The staff of professors for this immense body of students is equally remarkable. Thus at Vienna, there are in all 272 on the teaching body, including however, 127 honorary academical professors. At Berlin, the total teaching staff numbers 241; at Leipsic, 171; Prague, 150; Pesth, 143; Munich, 141; Breslau, 123; Göttingen, 119; Bonn, 110 and Heidelberg, 109.

To give an idea of the large sums spent by the German Governments on the scientific departments of their State Universities, it may suffice to mention the cost of a few of the departments of the new University of Strasburg. The total outlay on the buildings of this University, either now complete, in process of erection or planned, is £600,000 ($3,000,000). The department of botany has had a sum of £20,000 ($100,000) devoted to it; that of physics, £30,000 ($150,000); that of chemistry, including a residence for the director, £35,000 ($175,000). These items include the permanent fittings of the various laboratories, but not the apparatus and collections which have been partly inherited from former years, and are partly purchased from the annual allowances of the various departments.

The yearly budget of the chemical department amounts to £1,335 ($6,675), not including either the salaries of the two professors (about $4,000) or the cost of heating and lighting, which are defrayed by the University. It includes the salaries of five assistants (about $1,275) and the wages of four servants ($1,300), leaving a sum of £820 ($4,100) to meet the general working expenses of the departments, including the purchase of chemicals, apparatus, specimens, etc. The number of students working in the chemical laboratories at Strasburg is about 100.

(d) Higher Elementary Technical Schools in Germany.

The Commissioners have not found in Germany any schools which exactly correspond to the professional schools of France, already described. There have existed, however, since 1850, a number of schools known as Gewerbe Schulen (trade schools), originally intended to impart technical instruction to boys in training to become masters of small industries, foremen in works, etc. In these schools primary education is continued, and additional instruction is given in mathematics, descriptive geometry, drawing, elementary science and some

modern language. In none of these schools is any attempt made to give workshop instruction. In most parts of Germany these schools are now known as Lower Real-schulen and lead up to the Industrial School of Bavaria, or the higher Secondary Real School in other countries.

(e) Apprenticeship Schools in Germany.

In most of the apprenticeship schools of Germany, that is, schools for the training of workmen or foremen, instruction in pure and applied art combined with practical work in the shops forms an important feature of the curriculum. The earliest attempt to introduce schools of a technical character into Germany was due, as is well known, to the initiative of Dr. Von Steinbeis, after the great Exhibition of 1851. They have since spread over Southern Germany and Austria, and have recently been introduced into Prussia. Of these latter, one of the best arranged is the *Royal Fach Schule of Iserlohn*, in Westphalia, a district abounding in ironworks and collieries, this being the first school of the kind established in Prussia. It is a school in which industrial art adapted to metal work is combined with handicraft teaching. The Commissioners visited this school under the guidance of Dr. Reuter, who was formerly director of the engineering school at Komotau, and it was in consequence of the success of this and of the other trade schools in Austria that similar schools have begun to be established in Prussia. The school owes its origin to the want experienced by the manufacturers of the district of better preparatory instruction of the pupils who enter their works. It has been established only four years. The pupils of this school go through a three years' course, and are trained as designers, modellers, wood carvers, molders, founders, turners and pressers, chasers, engravers, gilders and etchers. The drawing copies for ornament are published by Veith of Carlsruhe. The subjects of instruction are in part theoretical and in part practical. The theoretical instruction comprises drawing in all its branches, modelling in wax and clay, the elements of chemical and physical science, mathematics, German language, history of art, metal work and technology. The practical instruction includes lessons in the different departments of work which the pupil is likely to follow, each pupil being required to state on entry in which particular branch of the industry he is desirous of special training. The hours of instruction are, in the morning, from 8 to 12 in the winter, and from 7 to 11 in the summer, and in the afternoon from to 2 to 6. In this, as in other technical schools, it may be noticed that the hours of instruction are much longer than in

schools in which there is little or no practical work, the alternation of mental and bodily exercise enabling the pupil to apply himself to school work without fatigue for a greater number of hours than is possible where the instruction is theoretical only.

The school is well fitted with workshops, having the necessary appliances including a six-horse-power gas engine, hydraulic press, a planing machine, a shaping machine from Chemnitz, as well as elaborate lathes for wood turning and metal turning, made in Vienna, England, Scotland and America.

The curriculum of the school instruction is interesting as indicating the general scientific and artistic teaching which all the pupils undergo before devoting themselves more particularly to any branch of special practical work.

Besides the day school, in which the pupils are engaged from 8 to 10 hours, there is an evening school in which a course of instruction occupying three hours is given, comprising model and ornamental drawing, German, physics and arithmetic. The instruction in the evening school is intended for the workpeople in the numerous manufactories of the district, and is almost wholly theoretical. £500 ($2,500) was subscribed for apparatus, etc., by the leading manufacturers of the district. The school budget is £850 ($4,250).

(f) Conversations on Artistic and Technical Instruction.

The professors [Lange of Munich and Mayer of Nuremberg] stated that the conviction is universal throughout the country that the various art and technical schools are exercising a most important influence upon their manufacturing industries. In their belief, they can only meet the competition of their rivals in their own and other countries by training their workmen in taste and skill, and their industries will prosper in proportion as they keep up the efficiency of their schools, and spread their influence among the workers themselves. On all hands this movement is progressing, and they are compelled to strain every nerve in order not to fall behind. And what is the result? They can see a superior taste in every object made by hand, as an outcome of these schools; and they they can now almost tell by the work, where the workman or designer has been trained. Taste has become almost like a man's handwriting, and they can recognize the man, or, at least, his school, in his work. The great Nuremberg craftsmen of old have not ceased to inspire their followers with some of their enthusiasm and noble feeling, although centuries have passed since they lived and worked in this city. The inhabitants are all proud of the old couplet—

"Nuremberg's hand
Goes through every land;"

and they claim that it is no mere figure of speech. And, if the artistic supremacy of Nuremberg is not marked at present as in olden times, it is because of the spread of art culture in other communities. Other influences materially interfere with the localization of art industries. In these days of quick and easy traveling, the fame of a school attracts students from a long distance, and clever students belonging to a town in which a good school is located, often finds it advantageous to remove to places less favoured, and there sell their cultivated talent to capitalists who can utilize it to their profit. Thus, not in Bavaria, or even in Germany only, but in many other parts of Europe, are designers and art workmen, who have been trained at the schools of Nuremberg and Munich, who now enrich the industries of their new homes.

The Kunstgewerbe schools of Munich and Nuremberg having been eminently successful in the training of industrial designers and art workmen, the professors were interrogated as to the methods adopted in the training of their students. They insisted that the student must first be taught to draw thoroughly, drawing being the language of his profession. "The groundwork of all design that is worth anything is art. If the student has any talent or art-feeling within him, his power of drawing will enable him to give it expression; but, without thought and imagination, there can be no originality of design. Mere knowledge of drawing will not make a man a good artist any more than knowledge of language will make him a poet; but designer and poet are helpless without the knowledge of the language by which their art can be expressed to others. Teachers need to study the peculiarities of their students, for all cannot be dressed in the same clothes, or combed with the same comb."

The students are drawn from all classes of society, except the highest. Many who go through the full three years' courses are the sons of small manufacturers of artistic objects. In Germany, the proportion of men in small industries, or who have small workshops in their own homes, is very large, as compared with England. Many students, especially those connected with building and out-door trades, only come in the winter, when out-door work is often suspended. Some intend to become teachers, and, as there are no normal schools in Bavaria for training teachers of drawing, these high schools are, to some extent, utilized by them. Such students are required to go through the technical courses according to the school programme, and their numbers—attending the Munich and Nuremberg schools—are really decreasing. On being asked if any students besides those attending only in winter, support themselves while attending the classes, Professor Lange stated that from seven to eight per cent. of his students at Munich may be called "half-timers," working outside the school a number of hours daily, often selling their designs or work in wood carving, modeling, glass or porcelain painting, etc., executed

either in the school or out of it. At present the number of students of the artisan class, who have been engaged in practical work before coming to the schools, or who do practical work out of school hours, is increasing. Such students, in the opinion of both professors, are generally the most successful. They come, as a rule, after two or three years' work, when they have begun to feel their deficiencies, and are really anxious to improve themselves. They may have, in the first instance, less expertness in drawing than the schoolboy of 16 who has enjoyed continuous instruction from his childhood, but, having had experience of practical work in a definite trade, they know what they want to learn, and they work with greater care and perseverance. One of the professors, in 1876, attended a congress of professors and promoters of design and art work, and the question was seriously discussed as to whether, in the first place, students should not be required to work at some trade for about two years before coming to the Kunstgewerbe school; and, in the second, whether apprentices engaged in art work should not be compelled to attend the school also. The congress was unanimous as to the importance of the dual principle, that the designer should know something of practical work, and that the practical workman something of design, but could not see its way to make it compulsory. At the Nuremberg school there are, in winter, 120 students who earn their livelihood by day, and study art in the evening. Some of the most valuable work in the school is executed by these students.

The Kunstgewerbe schools of Bavaria are greatly helped by the ordinary Fortbildung or night schools, which apprentices are required to attend during the evenings and on Sundays. These schools are almost invariably free; they supplement and continue the education received in the day schools, and are taken advantage of by middle-aged as well as young men, desirous of improvement. They are technical in the truest sense of the word; science and drawing are taught, in their bearing upon upon the industries of the students. The Fortbildung schools are nurseries which are constantly sending earnest students to the Kunstgewerbe schools, where their particular tastes are cultivated in the direction in which they can be made most useful. But for these intermediate schools, some of the cleverest designers and best art workmen would never have been discovered, for they would not have been induced to take the first steps in art culture, by which alone their talent was brought to light. The professors drew our attention to the very excellent examples of modeling, wood-carving, and smiths' and mechanics' work sent to the exhibition by several of the Fortbildung schools of Bavaria, work which, had it been done by any provincial art school in England, would have materially enhanced its reputation.

In olden times every workshop was a school, and the "werkmeister" was an artist as well as a handicraftsman. The apprentice went

though his course of seven years' apprenticeship and learned every detail of his master's business. All this has now changed, the workmen is ceasing to learn his trade. What with the exigencies of the military system, and the increasing division of labor, the training of the workmen in the old-fashioned way is impossible; he may learn a part of a trade in the workshop, but he seldom learns the whole of it. It is therefore all the more important that the school should step in and supply, as far as possible, the defects of our industrial system. Each trade has its theoretical as well as its practical side, and, considering that the workshop does less for the training of the apprentice than before, it is necessary that the school should do its part as thoroughly and systematically as possible. These schools represent the faith of the people, expressed on all hands, and supported by daily experience, that taste is one of the most important factors in industry. From nearly every trade the cry comes for more taste, more skill. It is not now a mere sentiment, that prompts governments and municipalities to make great sacrifices for these schools. They feel that the prosperity of their industries depends entirely upon the cheapness and attractiveness of their productions, and although the workshop may do something for the former, the latter depends upon the taste and skill of the employer, foreman, or artisan. As practical evidences of their success, these gentlemen conducted us over some departments of the Exhibition, in which the influence of their schools upon the workmanship of countless objects of manufacture was unmistakable.

(g) Influence of Technical Training on the Chemical Color Industry of Germany and Switzerland.

Among the coal tar color works visited by the Commissioners, were those erected on the banks of the Rhine, at Basle, by Messrs. Bindschedler and Busch. These works, though far less extensive than those of Messrs. Meister, Lucius and Brüning, at Höchst, or of the Baden Aniline and Soda Works, at Ludwigshafen, are carried on in a no less scientific spirit, and the general method of working adopted in all these establishments is identical.

The first principle which guides the commercial heads of all the Continental colour works, is the absolute necessity of having highly trained scientific chemists, not only at the head of the works, but at the head of every department of the works where a special manufacture is being carried on. In this respect this method of working stands in absolute contrast to that too often adopted in chemical works in this country, where the control of the processes is left in the

hands of men whose only rule is that of the thumb, and whose only knowledge is that bequeathed to them by their fathers.

On entering the works of Messrs. Bindschedler and Busch, one is struck in the first place with the adaptation of means to ends, with the substantially built, well-lighted, well-ventilated workshops, and above all, with the all-prevading cleanliness and neatness. But it is not of these things that we now desire to speak, but rather of the method by which their business is conducted. In the first place, then, the scientific director (Dr. Bindschedler) is a thoroughly educated chemist, cognizant of, and able to make use of the discoveries emanating from the various scientific laboratories of the world. Under him are three scientific chemists, to each of whom is intrusted one of the three main departments into which the works are divided. Each of these head chemists, who have in this instance enjoyed a thorough training in the Zurich Polytechnic, has several assistant chemists placed under him, and all these are gentlemen who have had a theoretical education in either a German University or in a Polytechnic School.

An important part of the system has now to be noticed, viz: That directly under these scientific assistants come the common workmen, who have, of course, no knowledge whatever of scientific principles, and who are, in fact, simple machines, acting under the will of a superior intelligence. The many and great advantages of this arrangement are patent to all; and the fact of having men of education and refinement in positions of the kind, renders the foreign manufacturer who adopts this system less liable to annoyance and loss (from sources which we need not more nearly specify) than his English competitor, who works on a different plan.

So much for the *personnel* of the works. Now for the mode in which they carry on their work. To begin at the beginning, we find no less than ten well-equipped, airy, experimental laboratories in these works, perfectly distrinct from the workshops where the manufacturing processes are carried on. In these ten laboratories the chief departmental chemists and their assistants work out their investigations respecting the production of new coloring matters, or the more economic manufacture of old ones. To assist them in their work, a complete scientific library is at hand, containing all the newest researches, for these, as we have said, form the material out of which the color-chemist builds up his manufacture, and no sooner do the results appear of a perhaps purely scientific research which may possibly yield practical issues, than the works-chemist seizes on them and repeats these experiments, modifying and altering them so as at last to bring them within the charmed circle of financial success.

Thanks to Dr. Bindschedler, we are able to quote a specially representative case, and a clear description of one such case is worth a host of generalities. Through the original investigations of Messrs. Emil

and Otto Fischer, the attention of the manufacturer was drawn to the leuco or colorless base obtained by the action of benzaldehyde on dimethylaniline, inasmuch as they stated that the salts of these colorless bases become green on exposure to air. Founded on these observations, an endeavor was made to effect the practical manufacture of a green coloring matter by oxidation of these colorless bodies. In order to attain the desired end, the following investigations had to be made by the chemist and his assistants who were to conduct the operations:

(1.) A cheap method had to be found for manufacturing benzaldehyde.

(2). A profitable mode of making the leuco-base had to be worked out.

(3.) The proper oxydizing agents and their best method of application had to be determined.

(4.) The best method of purifying and of crystalizing the green coloring matter had to be discovered.

The laboratory experiments on the above points having proved so far successful as to give prospects of good results, operations on a somewhat larger scale were started, and these yielding a satisfactory issue, the manufacture proper of the coloring matter, now well known as malachite green, on the technical scale was commenced; all the operations being watched by, and constantly being under the control of the chemists. But even now their scientific work is by no means ended. Continuous laboratory experiments go on for the purpose of finding improvements in the mode of manufacture. Thus, for example, the improved yield, both as to quality and quantity of the benzaldehyde is a matter of investigation. Again, the synthetic production of the pure leuco-base by a more direct process is sought for, so far as to get rid of loss in working, and to obtain a yield as close as possible to that pointed out by theory. In the same way improvements in the materials used for oxidation, and in their application, are made, so as to affect the oxidation quantitatively, without the formation of by-products. Lastly, the action of various solvents is examined, so as to obtain the best form of the crystallized coloring matter. As indicating the value of these improvements made after the color became a marketable article, it is only necessary to state that the price of the crystallized oxalate has been reduced from £2 ($10) to £1 4*s.* ($6) per kilo.

(h) Influence of Technical Training on the Beet-sugar Manufacture.

Probably no more striking illustration of the rise of a successful and most important industry depending upon the application of the scientific principles of engineering and chemistry can be found than in the Continental beet-root sugar manufacture. The increase in the consumption of sugar in this country has been very great. In 1843 it amounted to 200,000 tons; this figure was doubled in 1854; in 1874 it reached 850,000 tons, and in 1882, 1,000,000 tons of sugar were consumed in the United Kingdom. Of these quantities in 1870, 165,000 tons consisted of beet-root sugar, whilst in 1882, the total was over 400,000 tons, valued at £10,000,000 ($50,000,000). The whole of this amount is imported from Belgium, France and Germany, as no beet-root sugar is manufactured in this country.

To show the extent and growth of the Continental industry in a small country, we may cite the case of Belgium, with a population of 5,600,000. In 1846 the area under cultivation for beet-root was only 5,421 acres; in 1866 this was increased to 44,480 acres, and in 1882 to 86,490 acres.

The quantities of raw beet-sugar manufactured in Belgium were in 1880–81, 68,000; in 1881–82, 73,000; and 1883, probably 80,000 tons were manufactured in 156 works; that is, about one ton of sugar is obtained for one acre of beet-root crop. In France and Germany the area of beet crop and the consequent production of sugar is very much larger. The process of extraction and purification of sugar from beet are complicated and delicate, requiring both scientific knowledge and capital, as the plant necessary for working up the juice into refined sugar is of a very costly character, and the operations require careful and scientific handling in order to ensure success. The juice contains not only sugar crystallizable and uncrystallizable, but also a considerable quantity of inorganic salts and organic subtances other than sugar, and the presence of these latter ingredients *prevent?* a large portion of the sugar from crystallizing, and therefore *require?* to be removed. This removal of the injurious constituents can only be effected when an exact analysis of the juice and of the sugar has been made, and this must be done at each stage of the operation, so that the mode of working shall be properly regulated, and such an investigation is a somewhat complicated process, needing skilled chemical knowledge. The quantity of sugar which is rendered uncrystallizable by the presence of inorganic salts or ash is about five times the weight of the ash.

In order to obtain the sugar which would otherwise be thus lost, many processes have been adopted, and of these that involving the use of strontia is the most recent. This method was secretly worked for some years in certain works in Germany, but it has now been generally adopted under the patent of Dr. Scheibler, chemist to the

Beetroot Sugar Institution. By the use of the strontia process large profits have been made, and the plan has been successfully introduced into France and Belgium. The Continental beet-root manufacture, partly of course in consequence of the Government bounties, has been a very profitable one; annual dividends as high as 100 per cent. having been paid by some sugar-mills. It would seem, however, that owing to the great increase in the number of these establishments, the trade has seen its best days.

(i) Calico Printing—Alsace.

It is a noteworthy fact that, in nearly every instance, the employers and foremen of the establishments we visited, were men of high attainments. A great proportion of them speak English, and, from frequent intercourse with English machine makers and printers they are able to obtain accurate information on all matters relating to the development of their industry.

In every establishment there were trained chemists, some of whom were workmen who had gone through courses at the School of Chemistry in the town, or were at present attending classes during the evening. The employers themselves, who are practically interested in the school, take the greatest pains to promote its efficiency, constantly offering suggestions as to how the chemical instruction may be made systematic and practical, so as to be really useful to the industries of the district. They even open their works to the students of the school, who come at stated times in company with their professors, and are shown the manufacturing processes.

The interest of the large employers is not, however, by any means confined to the technical and scientific acquirements of their employés, and to the means by which such knowledge may be obtained. The opportunities afforded for instruction in art have long been of an extended and praiseworthy character; but not content with agencies in advance of any that may be found in any English town of the same population (64,000), the public-spirited inhabitants of Mulhouse are building, not, as is so usual on the Continent, out of State and municipal funds, but by private subscription, a new art gallery and museum for the study of Fine Art and Design, at a cost we were told of nearly £20,000 ($100,000).

Moreover, employers vie with each other in their contributions to the unrivalled Trade Museum of the town, of designs, patterns and choice examples of weaving and printing. The museum is open to the public, as well as all connected with the calico printing industry, and the benefactions to the Industrial Society are among the most remarkable illustrations of public spirit that we have witnessed.

Whenever the question was asked, the Commissioners found that the young men engaged in the various works attended the Drawing Schools of the town, and it is but reasonable to suppose that, as they are in constant contact with varied and beautiful designs, and are daily engaged in manipulating them in the different stages of their employment, they will bring to their Art instruction a quick perception of its useful applications, and will display in their industrial occupation a genuine and cultivated sense of beauty.

We found among the engravers employed in the various works, notable instances of young men who had received their entire instruction in the Engraving School, which is under the patronage and support of the Industrial Society. In fact every inducement is given to the poorest and humblest of the boys in the elementary schools, who show talent or proficiency in drawing, to attend first the Drawing School, and afterwards the Engraving School, where, without any cost to their parents, they are trained in all the processes of engraving for the calico printer, and are afterwards at liberty to sell their highly skilled labor at the best advantage, either in their own town or elsewhere.

(j) Textile Manufactures. Chemnitz, Saxony.

In conversation with employers and foremen, the importance of the weaving school of Chemnitz was everywhere acknowledged. One of the employers stated that its influence upon the manufacturing industries of Saxony could not be too highly estimated. We were told that there was not a fancy manufacturer in the town whose son, assistant or overseer had not attended some of the classes.

We paid an interesting visit to the warehouse and show rooms of one of the largest manufacturers in Saxony. The head of the firm, who takes the practical management of the business, had studied designing and weaving in the weaving schools at Lyons, and conspicuous in his office are some remarkable examples of silk weaving, in which the designing, setting of the cards in the loom, and the weaving of the fabric, were done by his own hands. He also studied chemistry at a Polytechnic School, and in his youth visited and worked at some of the chief dye works and factories in England.

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It was alleged, as one reason why these goods are sold so extensively in England, that similar goods are not made in England.

Their manufacture necessitates superior skill in designing and weaving, and a varied and technical knowledge of dyeing; these requirements, through the influence of technical schools, have been

carefully attended to and mastered in Chemnitz, but have not received the same attention in competing towns in England. He feared that England was awakening, and, if so, it would be so much the worse for him.

The designing in this establishment is executed by three head designers, who originate, and from six to eight assistants, who enlarge the designs on paper prepared for the purpose, and arrange them for the cards, which are then passed forward to the loom.

We saw two head designers at work, men apparently under twenty-five, and found, on inquiry, that both had been trained at the Industrial Art School at Dresden. In reply to a question as to the influence of Paris on the trade designs, we were informed that it did not suit the purpose of this firm either to send to Paris for designs or employ designers who had exhausted their originality at other places. * * * * * What they wanted and sought after was originality, combined with good taste, and these qualities could best be found in talented young men, full of inspiration and ambition, fresh from the best schools and teachers. These young men from Dresden were doing excellent work, and as they had a style of their own, or at least a style that was not an imitation of Parisian methods, the firm was able to offer novelties which attracted customers, and the business prospered in consequence. We ascertained that the knowledge of these designers did not go beyond the power of drawing and painting the designs themselves; the technical part of the work had to be done by the six or eight assistants who had attended the Chemnitz Weaving School. In this instance the Industrial Art School at Dresden had supplied the artist; the Chemnitz Weaving School the more technical designer, who *applied* the work of the artist to the actual capabilities of the loom. Neither could do the work of the other. Our conductor was of opinion that, as far as possible, the same training should be gone through by both. The artist should be taught to transfer his picture to the loom, and the technical designer to produce a design for himself. It ought to be the main purpose of the weaving school, in carrying out its highest functions, to bring the artist to the loom and the weaver to the studio.

The Chemnitz Weaving School is to be credited with much of the variety and excellence of the textile manufactures of the district, and with the greater power of adaptation from one class of goods to another, than is found in similar manufacturing towns in England, where no such schools exist.

(k) Engineering and Machine Works.

In Berlin we visited the engineering works of Messrs. Borsig, where 1,400 men are employed, and were shown, with the greatest liberality, over every part of the workshops.

Fourteen draughtsmen are employed in the works, all of whom have had a scientific education, and most some experience in the workshop besides.

On inquiring as to the education and training of the head draughtsman, he informed us that, after a fair scholastic education, and a year's experience of practical work in an engineering shop, he entered the Polytechnic at Zurich, and went through the Engineering Course. Thence he traveled to England and took a situation as engineer and draughtsman at a large engine works in Manchester. He remained here two or three years, acquiring all the information he could obtain relating to the science and practice of engineering, and then came to Berlin, where he readily received an engagement at these important works. This gentleman was of opinion that the plan which he had followed had been of advantage to him. He did not believe that a young engineer could obtain the necessary education entirely in school. The Polytechnic School course, although very thorough in its way, would be most useful to a student acquainted with practical work. He would recommend a good general education, to be followed by a year in a workshop, and afterwards by a Polytechnic School training.

(l) Works of Messrs. Siemens and Halske (Electrical Engineers), Berlin.

At these works from 800 to 900 men are employed, and the firm have other works employing 1,600 men, thus making a total of 2,400.

We were conducted over the works by Dr. Werner Siemens, brother and partner of the late Sir William Siemens.

He was of the opinion that in Germany there are more Polytechnic Schools than are necessary. Their number was due to the educational rivalry of the several German States, each of which had aimed at achieving technical superiority over the rest. The motive was excellent, but the result had been costly; yet, considering that the standard of education throughout Germany had thereby been raised, the people felt that their sacrifices had been more than justified. The number of Polytechnic Schools might wisely be reduced, and the money thus saved might be devoted to the establishment of intermediate schools, which are much needed.

As to the education of workmen, everything depended upon the

means and natural abilities of the student. He would give, first, a sound elementary education up to 14. At that age it was natural that the workman's son should be required to earn wages and learn a trade, but he ought to attend a night school. After two or three years he should enter, if he could dispense with wages, a foremen's school (like that at Chemnitz), from which, by showing remarkable ability, he would be able to pass to the highest technical schools. If a young man were compelled to work for wages in order to maintain himself, the above course would be impossible. The night school, however, was still open to him, and the highest possibilities were accessible to perseverance and ability.

In his own works he selected young men of promise, and paid their expenses at these schools, in some cases dividing the year between school and work, so as to enable the students to keep up the connection between the school and shop. The great problem with him had been to find and train the most promising youths. Although it too often happened that he lost the services of the men after they had been improved, yet in the main the advantages compensated him for the sacrifices. Dr. Siemens said that workmen in other trades very commonly save up their money in order to have a course of schooling, and attend classes in the slack times of winter. Many employers assist their young men in this endeavor to improve themselves, and consider that the gain in increased efficiency is worth the outlay. Dr. Siemens considers it well worth the while of the State to seek out talent wherever it can be found, and to develop it for the benefit of the State as well as of the individual. The foundation of bursaries for this purpose, uniting the shops and the schools, would be very useful, for it often happens that a young man's talent is only brought out by the practical application of scientific principles at the bench or forge.

(m) Works of Messrs. Hartman & Co., Limited, Chemnitz.

On a previous visit to this establishment 10 years ago, by one of the Commissioners, he was informed that for many years previous it had been a condition of the firm that apprentices should attend the classes of the Technical school. It appeared that the custom was not confined to one establishment, as there were also students in the school from other large machine shops of Chemnitz.

In Chemnitz, as in other industrial centers, we came in contact with the leading employers and engineers, who freely gave their opinions upon questions relating to the education and training of men of their class. There were differences of opinion in matters of detail; some

gentlemen of high authority and large experience were in favor of teaching the use of tools in elementary schools, continuing this workshop practice in more highly equipped Technical schools, and thus preparing the engineer, by the union of theoretical knowledge with its application at the bench, for actual practice without apprenticeship. Others were opposed to the introduction of machinery into schools, beyond such models as would be useful for the illustration or demonstration of scientific principles, and preferred leaving the actual teaching of the trade *entirely* to the workshop. But the advocates of both systems were agreed as to the great importance to all young men qualifying as engineers, of attending night schools, or by other means acquiring a knowledge of mathematics, applied mechanics, and mechanical drawing, at the same time that they gained workshop experience.

The German school-taught engineer was strong in the knowledge of the principles of mechanics and physics and in mechanical drawing. He was, however, deficient in workshop practice, and in the knowledge of men; qualities which could only be acquired by experience. And since nine out of every ten engine and machine shops were engaged upon stereotyped machines made according to pattern, it was more important to have an overseer who knew thoroughly how the work in hand should be done, and how to manage the artisans under him, and who could thus secure the end that all were striving for, viz: a cheap and effective machine, rather than to have an overseer who understood principles, which he had no opportunity of carrying into practice, but was inferior in practice and in the power of getting cheap and effective work out of his men. Mr. B. was of opinion that the English system erred in the direction of too little theory; the German system in that of too little practice. Of course, he would admit that a man could not have too much practical or theoretical knowledge, if it were possible to combine them, but so long as a man's training was limited by its cost in time and money, he was strongly of opinion that it was not advisable to run the risk of sacrificing practice to theory. The new Schools of Engineering in Germany, and particularly the Higher School at Chemnitz, were modifying their courses so as to secure adequate theoretical training, with as little sacrifice as possible of that equally important experience which could only be obtained in the workshop.

(1) The Iron Industries of Westphalia.

Great importance is attached to the attendance at evening schools of all boys employed in the works. It would be considered in England that a boy who had gone through the strain of 12 hours piece work among the furnaces of an iron works would be entitled to all the relaxation he could get in the evening. It is not so at Dortmund. The directors of these works require all boys under 18 to attend the Fortbildung schools of the town on two or three evenings a week, and the boys are required to attend the Sunday schools. (As we have already explained, the reader must understand that the Sunday schools of the Continent, so frequently referred to in this report, are not schools for religious teaching, or connected with religious organizations in the same way as those of England. They are invariably public, municipal, trade-guild or State schools, intended for supplementing the education of the day school. Many are advanced schools, strictly technical in their aims, giving instruction in science and drawing bearing upon the local industries.) At these works a register is kept of the attendance of the boys at evening schools, and is daily examined by an overseer in charge. Parents willingly cöoperate with employers in securing the attendance of apprentices at school, and we were told that the boys generally appreciate the school and make substantial progress.

The expenses of the Fortbildung schools are defrayed by the town. They are held in the municipal day school's building, and day school teachers conduct the classes. Besides a school for mining deputies at Dortmund, a "Werkmeister" school has been quite recently formed at Bochum for the special education of foremen of ironworks. It is supported entirely by the iron manufacturers, who contribute in the ratio of the number of men they employ. No man is admitted unless he has been four years at work in some branch of the iron industry, and has shown superior capacity and conduct. The students go through a course of practical metallurgy and of the other sciences bearing on their trade.

One of the directors of the works, who takes great interest in the school, stated that at present it was exceedingly difficult to find scientific knowledge and workshop skill and experience united in persons of the class of foremen. Trained simply in the works, they necessarily knew but little of the sciences of metallurgy and chemistry. The polytechnic students who had mastered the sciences were often useless in the works. It was the intention of the school to engraft some knowledge of principles on the practical skill of the workmen.

The director expressed a strong opinion that the works training in Germany is less thorough than that of England. If any country could claim natural aptitude for a particular industry, England might fairly claim preëminence in iron. Germany cannot look back upon

generations of skilled and practical men; the stimulus of high rewards directing talent to mechanical pursuits; the boundless capital at command to develop inventions; and until lately Germany has not been able to match the men of talent who, from time to time, have arisen in England to revolutionize the trade. A combination of circumstances has long helped to strengthen England in what had been so long, but was now no longer, her great iron monopoly. For many years the best that other countries could do was to follow; and, in strengthening their weak places, they were compelled to look to education as their most important aid. Let education, said the director, be sound and thorough, so far as it goes. If a boy must leave school at 14 or 15, in order to earn his livelihood, there is no good in teaching him a great variety of subjects. Give him, as far as the time will admit of it, the tools which will enable him, as opportunities arise, to dig knowledge for himself. A smattering of many things does not make a boy clever, but often makes him conceited; it persuades him that he is intended for something better than swinging a hammer or using a file. If a man must earn his living by his hands, give him an education that will help him to do it; teach him drawing, the rudiments of science, modelling; ground him well in arithmetic. There is no good in a working boy receiving a "fancy" education at somebody else's expense, when that education rather hinders than helps him in his work. If, on the other hand, a boy has exceptional talent, by all means cultivate it, and do not grudge the cost in public money, for the public as well as the boy will reap the advantage of it.

(m) Engineering and Mechanical Industries in Bavaria

In making the tour of one of the large engineering establishments in Bavaria, we were accompanied by an English manager of great intelligence and experience, who expressed very definite opinions on several important matters relating to this inquiry. * * * * Germany 30 years ago, as compared with England, was simply "nowhere," but, placing English and German works side by side now, we should find that the progress in the latter has been positively marvelous. During all these years the Germans have been following the English, step by step, importing their machinery and tools, engaging, when they could, the best men from the best shops, copying their methods of work, and the organization of their industries; but, besides this, they had devoted special attention to a matter which England had almost ignored, the scientific or technical instruction of their own people. And what has been the result of all this? They have reached a point at which they have but little to learn from the

English. He called our attention to a fact, which had not escaped our observation before, that, now-a-days, there are scarcely any Englishmen to be found at the head of German workshops. It no longer pays to import them. In earlier days the Englishman was completely master of the situation. Practical knowledge counted for everything, and this was the Englishman's possession. In theory he was deficient. During recent years, there has been less and less demand for English foremen on the Continent, where practical knowledge has increased, and more and more demand for Continental men of science in England.

"Give the English workmen the same schooling as the German," remarked Mr. A, "which will improve him both as a mechanic and as a man; keep him from soldiering, and teach him to avoid drink, and no workman in the world will have a chance against him."

The German system of education, in which the sciences underlying mechanical industries are taught, combined with the English system of workshop practice, form his ideal of the training for an engineer, mechanic or builder. England must not be content to rest on her undoubted superiority in workshop appliances and organization; she must master the theoretical as well as the practical. "Keep to your shops," said Mr. A., over and over again, "and follow the Germans in scientific teaching; English industries will then take a new lease."

(n) The Royal Fachschule of Iserlohn, Prussia.

The object of this Institution, as an Academy of Arts, is to impart a thoroughly sound education, at once scientific, technical and manual. The subjects comprehend the manufacture of iron, copper, brass, bronze, nickel and silver.

To aid the students in acquiring a comprehensive, well-grounded, practical knowledge of the diverse processes and successive stages of manufacture in those metals, they have the advantage of spacious drawing halls, auditoriums, workshops replete with all necessary apparatus, instruments, tools, machinery, etc., and a steam engine of six-horse power, all within the walls of the institution.

The establishment is conducted under proper supervision in every department, and all suitable measures are adopted to maintain the students in vigorous health, both of body and mind. From time to time excursions are made to visit the picturesque scenery of the neighborhood, as well as into Rhenish Prussia, and visits are paid to the large industrial establishments in the district.

The terms for the science instruction begin after the Easter vaca-

tion, but instruction in manual work can be commenced at any time. No student is bound to attend all the branches of instruction specified in the prospectus.

The school fee is £1 ($5) per quarter.

Prospectus.

A. Scientific Education.

FIRST YEAR.

1. Model Drawing.
2. Ornamental Drawing.
3. Geometry.
4. Geometry Applied to Design.
5. The German Language.
6. General Arithmetic and Book-keeping.
7. Algebra.
8. Natural Philosophy.

SECOND YEAR.

1. Ornamental Drawing.
2. Anatomical Drawing (the human figure).
3. The Science of Shadows.
4. The Science of Perspective.
5. The German Language.
6. The Science ol Projection.
7. Mechanical Calculations.
8. Natural Philosophy.
9. Technical Chemistry.
10. Mechanics.

THIRD YEAR.

1. Composition and Designing.
2. Drawing from the Antique.
3. The History of the Arts.
4. The German Language.
5. Natural Philosophy.
6. Technology.
7. Technical Chemistry (laboratory).
8. Statistics.

B. Manual Education Division.

FIRST YEAR.

1. Modeling in Fine Clay.
2. Carving Wood.
3. Molding and Carving in Gypsum.
4. Molding in Sand.
5. Chipping and Filing.

SECOND YEAR.

1. Modeling in Wax.
2. Carving in Wood.
3. Carving in Gypsum.
4. Molding in Sand and Wax.
5. Casting in Bronze.
6. Shaping.
7. Planing.
8. Drilling.
9. Turning in Wood.
10. Turning in Metal.
11. Chasing in the Lathe.
12. Pressing, Stamping and Coining.

THIRD YEAR.

1. Forging.
2. Soldering.
3. Burnishing.
4. Embossing.
5. Chasing.
6. Engraving.
7. Etching.
8. Scouring.
9. Varnishing.
10. Galvanizing.
11. Nickel Plating.
12. Fire Gilding.

THEODORE REUTER, *Director.*

III. GREAT BRITAIN.

Great Britain is far behind Germany, France or the United States in establishments for both higher and lower technical training, and has barely begun in isolated instances anything like manual training in the public schools. There is not in the United Kingdom a technical institution of the grade of the Massachussetts Institute of Technology, not a manual training school, as far as the commission has been able to ascertain, of the grade of the Philadelphia, the St. Louis, or the Chicago Manual Training School.

The subject is, however, awakening very great interest among public men and educators, and there is every indication that that country will not long be content to occupy its present position of interiority. A powerful impulse in this direction was given by the publication of the successive reports of the Royal Commissioners on Technical Instruction, from 1882 to 1884, which embodied theresults of an extended and painstaking inquiry into the extent, the methods and the results, both educational and practical, of such instruction, in those countries of Europe where it had received the greatest development. Evidence of this increasing interest, in addition to the fact of the appointment of the Commission named, may be found on pages 6 and 7 of the present report.

A most important preparation for the new departure has been made in the operations of the Science and Art Department, which the Government has maintained for more than thirty-five years past, at a large expense, but, by general confession, without commensurate results. The amount appropriated to this Department in 1887–8, was £438,558.

(a.) Popular Science Teaching.

This Department began operations in 1837, as a "normal school of design with a museum and lectures," with an annual appropriation of £1,500. By 1851, seventeen branch schools of design had been established in various manufacturing centers, and the appropriation for their support had increased to £15,055. The Science Department was added in 1853, with Dr. [now Sir] Lyon Playfair as executive head of the joint Department, and the general scheme adopted was, to establish in the metropolis, a school of the highest character and to give partial aid to local institutions for Science instruction, such institutions being made as largely self-supporting as possible. But no general system of making grants applicable to the whole country was formulated until 1859. Rules were then adopted under which any place might establish Science classes and obtain State aid.

The subjects, toward instruction in which aid was obtainable, were at first only the following:

1. Practical, plane and solid geometry, with mechanical and machine drawing.
2. Mechanical Physics.
3. Experimental Physics.
4. Chemistry.
5. Geology and mineralogy.
6. Natural history, including Zoology and Botany.

The aid consisted of certificate allowances, earned by passing a certain number of pupils; additional payments for pupils who obtained prizes; grants toward the purchase of apparatus, books, etc.; and prizes and medals to the students. As the certificate allowance was treated as a maximum sum obtainable, portions only of which were payable on the success of each pupil, this form of aid is generally known as "payment on results."

New schools and classes were rapidly formed, so that in May, of 1861, there were thirty-eight classes with 1,330 pupils under certificated teachers. The number of schools (each institution where Science instruction was given being counted as a school) had increased in 1886, to 1,682, with 5,862 classes in different subjects, and 94,838 students under instruction. In order to obtain State aid, each school or class must be under a properly constituted and approved local committee of at least five known and responsible persons. The subjects, towards instruction in which aid is granted, are as follows:

1. Practical plane and solid geometry.
2. Machine construction and drawing.
3. Building construction.
4. Naval architecture.
5. Mathematics.
6. Theoretical mechanics.
7. Applied mechanics.
8. Sound, light and heat.
9. Magnetism and electricity.
10. Inorganic chemistry [theoretical].
10p. Inorganic chemistry [practical].
11. Organic chemistry [theoretical].
11p. Inorganic chemistry [practical].
12. Geology.
13. Mineralogy.
14. Animal physiology.
15. Botany.
16. Biology, including animal and vegetable morphology and
17. Physiology.
18. Principles of mining.
19. Metallurgy [theoretical].
19p. Metallurgy [practical].
20. Navigation.
21. Nautical astronomy.
22. Steam.
23. Physiography.
24. Principles of agriculture,
25. Hygiene.

Each subject is subdivided into three stages or courses—the elementary, the advanced and honors—except mathematics, which is subdivided into seven stages, with "honors" in three groups or stages.

The assistance granted by the Science and Art Department is in the form of—

1. Examinations, in which Queen's prizes and medals are awarded, held annually about May, at all places complying with certain conditions.
2. Payments on the results of examination and, to a limited extent, on attendance.
3. Scholarships and exhibitions.
4. Building grants, and grants towards the purchase of apparatus, etc.
5. Supplementary grants in certain subjects.
6. Aid to teachers in training while attending the Normal School of Science and Royal School of Mines, South Kensington.

Payments are made on the results of the May examinations on account of the instruction of students of the industrial classes—all those whose incomes do not exceed £200 a year being included in this category—or of their children. The payments are:—£2 for a first class, and £1 for a second class, in the elementary and in the advanced stage, and £2 and £4 for a second or first class, respectively, in honors. Further payments are made for attendance in organized science schools; and for practical chemistry and practical metallurgy. Before payments on results can be claimed, at least 28 lessons must have been given to the class, and each student on whose account payment is claimed must have received at least 20 lessons.

The *Science and Art Scholarships* are awarded in competition among the pupils of any elementary school or schools; the absolute terms of the competition and the award of the scholarship being left to the managers of the school, subject to the approval of the Department of Science and Art. The object of the scholarship is to provide a maintenance allowance for the successful competitor while pursuing his studies, for one, two or three years, at a day school approved by the Department. This day school may be either the school in connection with which the scholarship is awarded, or a school where instruction of a more advanced character is given. The committee of the local fund contribute £5 each year. For the first year the local contribution is supplemented by the Department with a grant of £4; for the second year with a grant of £7, and for the third year with a grant of £10. But it rests with the locality to decide whether the scholarship shall be tenable for one, two or three years. With any number of pupils up to 100 on the register of the school, or group of schools, there can be but two such scholarships; above 100 and up to 150, three; above 150 and up to 200, four scholarships, and so on.

The scholar must be a student of the industrial class, as defined in the Directory, and at the time of first appointment must be under 16

years of age. He must continue regularly to attend a day school, and, at the close of the first year, pass in one or more subjects of science, or of second grade art; at the end of the second year, obtain a higher class in the subject of science in which he has already passed, or pass in some other subject of science, or in another subject of art, second or third grade, and at the end of the third year pass in the advanced stage of a subject of science in which he has not already passed in that stage, or in another subject of art, second or third grade.

The *Local Exhibition* is to enable the holder to complete his education at some college or school where a thorough course of science or of art instruction of an advanced character may be obtained. Grants of £25 per annum, for one, two or three years are made for this purpose when the locality raises a like sum by voluntary subscriptions. And if the student attend a State school, such as the Normal School of Science and Royal School of Mines in London, the National Art Training School, the Royal College of Science, or the School of Art, in Dublin, the fees are remitted. The exhibition must be awarded in competition at the examinations of the Department.

National Scholarships are given, tenable at either the Normal School of Science and Royal School of Mines, London, or at the Royal College of Science, Dublin, at the option of the scholar. They entitle the holders to free instruction for three years, and to a maintenance allowance of 30*s*. a week during the session of about 40 weeks each year. The scholarships are only open to students of the industrial class. Twelve are awarded each year.

Building grants are made in aid of a new building (or for the adaptation of an existing building) for a school of Science at a rate not exceeding 2*s*. 6*d*. per square foot of internal area, up to a maximum of £500 for any one school, provided that certain conditions are complied with, and that the school be built under the Public Libraries and Museums Act, or be built in connection with a School of Art, aided by a Department building grant.

Additional aid is provided from the income of scholarships founded by the late Sir Joseph Whitworth in 1868. According to the latest regulations, each candidate for a scholarship is required to have worked at least two years in a mechanical workshop or drawing office, and no scholar is permitted to occupy any office of profit while holding his scholarship. There are 30 such scholarships, each tenable for one year, some being of the value of £100 and the rest of £50 each; and twelve scholarships, tenable for three years, of the value of £125 a year each, four to be awarded each year. The competition is in theoretical subjects and the limit of age on appointment is 22 years.

From the first establishment of this system special attention has been given to the subject of supplying a sufficient number of properly trained teachers. In 1859, the demand for such teachers did not exist and had to be created. There were but few places in which a man

could earn his living by science teaching alone. Teachers were required to have a certificate of competency from the department, and it was necessary to induce men connected with the locality, who had other occupations and means of subsistence, to undertake Science teaching in their leisure time.

For some years it was found convenient to provide the necessary training for teachers in the Royal School of Mines, and out of this experience grew the organization, in 1881, of "The Normal School of Science and Royal School of Mines," which is now an institution to supply systematic instruction in the various branches of Physical Science to students of all classes. While the school is primarily intended for the instruction of teachers, and of students of the industrial classes selected by competition in the examinations of the Science and Art Department, other students are admitted so far as there may be accommodation for them, on the payment of fees fixed at a scale sufficiently high to prevent undue competition with institutions which do not receive State aid.

The subjects taught in the school are mechanics and mathematics, physics, chemistry, biology, including zoology and botany, geology and mineralogy, agriculture, metallurgy and assaying, mining, elements of astronomical physics, practical geometry, mechanical and freehand drawing. The course of instruction is arranged in such a manner, as to give the students a thorough training in the general principles of Science, followed by advanced instruction in one or more special branches of Science.

(b.) Art Teaching.

We have already noted the fact that the Department was established for the purpose of "extending a knowledge of the arts and of the principles of design among the people (especially the manufacturing population) of the country." In 1852, the schools of design were reorganized and the "Department of Practical Art" added. The principal objects of the new Department were to be—(1.) The promotion of elementary instruction in drawing and modeling; (2.) Special instruction in the knowledge and practice of ornamental art; (3.) The practical application of such knowledge to the improvement of manufactures.

Provision was also made to encourage the establishment of a new class of Schools of Art. These were to be maintained by local effort with conditional aid from the Department, which was granted wherever a local committee was willing to establish day and evening classes for artisans, to appoint a certificated master, to assign to him part of the fees of the school, and to engage him to teach drawing in at least

three elementary day schools. The aid from the Department consisted in payments of £10 on each certificate held by the master, in grants towards the cost of examples, and in medals and prizes awarded on a selection of the works sent to London for examination.

In 1854, inducements were offered to teachers of elementary schools to qualify in Drawing, by the offer of payments on the results of their instruction of the pupil-teachers in their schools; and the pupil-teacher system was extended to Schools of Art, a payment of £15 a year being allowed for each pupil teacher. In 1855, the Department offered prizes to children in elementary schools taught drawing by masters of Schools of Art. In 1856, these schools were collectively examined at Schools of Art, by the Inspectors of the Department, and in 1857, a payment of 3*s.* for every child who obtained a prize was given to the art master who had taught him. In the same year an augmentation grant of £5 was made to the salaries of teachers of elementary schools who had passed examinations in drawing, and taught the subject satisfactorily in their schools.

Since 1864, Schools of Art and Art classes send their works annually, in April, to South Kensington, where they are examined by Committees of Examiners who award the marks on which payments are made and medals and prizes given.

Aid is given to—

(*a.*) Elementary schools.

(*b.*) Training colleges.

(*c.*) Schools of Art and Art classes.

(*a.*) The aid may be obtained by public elementary schools under the inspection of the Education Department, and by other schools if they come within the definition of elementary schools in section 3 of the elementary education Act of 1870.

The aid is given on the following conditions:

1. The instruction in drawing must be given by a duly qualified teacher of the school, or by the teacher of an Art School or Art class.

2. Drawing must be regularly and continuously taught throughout the school for at least one and a half hours each week, throughout the year; except that girls need not be taught drawing, and no grant is made on account of the instruction of girls in drawing, unless they are also taught English, needlework and cookery.

3. The school is examined in drawing, once in a year, by a local Inspector appointed by the Department of Science and Art.

4. The scholars may be classified for instruction and examination in drawing in standards not corresponding to the ordinary standards of the school; but every scholar must, as a rule, be examined in a higher standard in each successive year.

5. The seven standards of examination in drawing * are:—I. Draw-

* An illustrated syllabus of the course of instruction in drawing may be obtained from the Department of Science and Art, price 2*d.*

ing *on slates*, freehand, and with the ruler, of lines, angles, parallels and the simplest right-lined forms. II. The same *on paper*. III. (*a*) Freehand drawing of regular forms and curved figures from the flat; (*b*.) Simple geometrical figures with rulers. IV. (*a*.) Freehand drawing from the flat; (*b*.) Drawing from simple rectangular and circular models; (*c*.) Simple scales and drawing to scale. V. (*a*.) Freehand drawing from the flat; (*b*.) Drawing from easy common objects; (*c*.) Geometrical figures with instruments and to scale. VI. (*a*.) Freehand drawing from the flat; (*b*.) Drawing from models of regular forms and from easy common objects; (*c*.) Plans and elevations of plane figures and rectangular solids in simple positions, with sections (not required in girls' schools). VII. (*a*.) Freehand drawing from the flat; (*b*.) Drawing any common object and casts of ornament in light and shade, *or* (*b′*.) Geometrical drawing more advanced than in V; (*c*.) Plans and elevations of rectangular and circular solids with sections (not required in girls' schools).

6. Registers must be kept of the attendances of the scholars; and all scholars whose names have been 22 weeks on the register, at the end of the school year must be presented for examination.

7. A grant of 1*s*., 1*s*. 6*d*., or 2*s*. per scholar in average attendance is paid on the results of the examination, if the award be "fair," "good," or "excellent" respectively; and cards of merit are given to scholars who pass with credit in standards VI and VII. A grant of 10*s*. is made for each second grade examination paper satisfactorily worked by a pupil, teacher or ex-standard scholar of the school.

8. The minute also provides for grants by the Department of Science and Art for the drawing in evening schools under the inspection of the Education Department.

(*b*.) Annual examinations are held about October, at the Training Colleges under the inspection of the Education Department.

The subjects of examination are—freehand drawing from flat examples; practical geometry; linear perspective; model drawing and drawing on the blackboard.

A payment of 10*s*. is made to the Training College for each subject of the examination in which a student passes, and prizes and certificates are given to all candidates whose papers are marked "excellent."

Grants are also made towards the purchase of suitable apparatus.

(*c*.) There are twenty-three stages of art instruction towards which aid is granted to Schools of Art and Art classes, which have been duly recognized by the Department.

This aid to Schools of Art and Art classes is in the form of—

1. Examinations, in which prizes are awarded, held at all places complying with certain conditions; and medals and prizes are awarded on works executed during the year.

2. Payments on the results of examination, and on the works executed in the school or class during the year.

3. Scholarships, local exhibitions and free studentships at the National Art Training School and at local schools of art.

4. Supplementary grants in respect of teachers, art pupil teachers, modelers and other students.

5. Building grants and grants towards the purchase of examples, apparatus, etc.

6. Special grants and loans of works of art, books, etc.

Payments are made on the results of the examinations of students of the industrial classes—all those whose incomes do not exceed £200 a year being included in this category—or of their children. There are two kinds of examination—(*a*) Second and third grade personal examinations, held about May; and (*b*) the examination of works executed by registered students in schools and classes, which works are sent to the Department of Science and Art for that purpose, in April.

The payments to Schools of Art and Art classes are as follows:

(*a*.) £1 and 10*s*. respectively for a first class or second class in each subject of the second grade examination.

(*b*.) £1 and 10*s*. respectively for a first class or second class at the second grade examination in modeling. This payment can only be claimed on account of a student who has attended at least 40 lessons in modeling during the school year in a School of Art or Art class under the instruction of a master holding a third grade certificate.

(*c*.) £1 10*s*. for a pass in the third grade examination in stages 3*b*, 5*a* and 5*b*.

(*d*.) £3 and £1 10*s*. respectively for a first class or second class in other subjects of the third grade examination.

(*e*.) £2, or a sum not exceeding £2, for works sent up, other than those which are preliminary to personal examinations, executed during the previous year by a student in the rooms and during the recognized meetings of schools or classes.

Grants are made to enable the masters and students of Schools of Art to visit the South Kensington museum and other metropolitan institutions, and to go abroad for study.

Aid not exceeding 50 per cent. of their cost is given towards the purchase of examples, apparatus and fittings.

Building grants not exceeding 2*s*. 6*d*. per superficial foot of internal area are made, up to a maximum of £500 for any one school, in aid of a new building, or of the adaptation of an existing building for a School of Art.

The following figures show the extent and amount of the aid of Art instruction under the foregoing heads.

In 1886 there were—

205 Schools of Art with 21 branch classes, and a total of 40,134 students—the fees paid by the latter amounting to £40,643, and the payments on results to £27,742.

525 art classes, with 31,491 students. The payments on the results of Art examinations, in Art classes and Science classes together, amounted to £9,486.

4,446 elementary schools at which 870,491 children and pupil-teachers were taught drawing, of whom 588,265 were examined—the payments on results amounting to £33,284.

50 Training Colleges, with 3,620 students in training examined in drawing, of whom 935 students and teachers obtained certificates, the grants amounting to £2,161.

The whole number of persons who received instruction in Art in some form, through the agency of the department was 956,524.

The following table shows the numbers receiving instruction in Art during the years 1876 and 1886 compared:

	Year.	No. of Schools.	Persons taught.	Examination papers worked.	Works sent up.	Fees.	Direct payment on results.
Schools of art,	1876,	141	27,973	26,100	122,553	£33,348	£15,834
	1886,	205 and 21 branches.	40,134	39,458	322,040	40,643	27,742
Art classes,	1876,	883	31,158	20,390	118,535	*	6,318
	1886,	525	31,491	28,018	256,422	5,872	7,207
Science classes sending up art work,	1876,	86	1,547	......	13,885	*	514
	1886,	379	10,788	......	141,782	*	2,279
Elementary Schools,	1876,	3,335	460,961	360,159	......	*	22,063
	1886,	4,446	870,491	672,916	......	*	33,284
Training colleges,	1876,	47	3,685	10,799	......	*	1,285
	1886,	50	3,620	9,610	......	*	2,161
Summary,	1876,	4,492	525,324	417,448	254,973	33,348	46,014
	1886,	5,626	956,524	750,002	720,244	46,515	72,673

* No return.

It is evident from the foregoing sketch, which is condensed from an account contained in the "Calendar and General Directory of the Department of Science and Art for the year 1888," that a vast amount of money and effort has been expended, both by the Government and by individuals and localities, for the promotion of science and art among the people, and with the avowed object of helping England by this means to retain and insure her industrial supremacy. The results have been by no means unimportant, and if nothing more had been done than to secure the establishment of the magnificent museum at South Kensington, with its group of related institutions, the return would have amply justified the outlay. But whatever advantages, direct or indirect, may have accrued to the national industries from these sources, thoughtful Englishmen are free to admit that they have not met the desires or expectations of the general public or of those best able to judge. The deep-seated movement now going on in that country, in behalf of better *Technical* and *Industrial education*, is in part, at least, an expression of that dissatisfaction; though it has also a positive purpose, looking to the incorporation of a practical element with the theoretical already provided for. The feature of the present system which is most generally criticised is its fundamental principle of "payment on results."

This, it is alleged, has resulted in a national system of "cramming" for examinations, and of such teaching as "cramming" requires—a system which suppresses all spontaneity of intellectual action and makes the mind a mere receptacle—a sort of living phonograph.

This criticism, however much of truth it may contain, does not in our opinion touch the vital point of the difficulty. If this extended system of Science and Art teaching had been accompanied with anything like an equal amount of manual training in the use of tools and in laboratory manipulations, thus giving concreteness and reality to the subjects of instruction, we believe the results would have been incalculably more effective, and in the direction in which they were sought. In fact, this passage in educational history furnishes a most convincing demonstration of what a correct system of Technical and Industrial education *should* be, by showing in what ways a defective system has failed. It shows that no amount of theoretical training can supply the lack of even a moderate amount of practical hand training, provided the latter be skilfully directed, on educational methods, and with a view to illustrating the principles involved. We may quote, on this point, a brief passage from Professor Silvanus P. Thompson, the accomplished Principal of Finsbury Technical College.

Says Professor T., "But, as it happens, those of our national industries which have felt most severely the depression in trade are, for the most part, those in which skilled labor tells for a great deal; the iron and steel industries; the industries in cloth, in weaving, dyeing, and spinning; the industries in silk, in ribbons, in tools, in watches.—We need not further particularize. The lack of Technical Education is costing us dearly—has cost us terribly dear—in spite of the oft-repeated warnings

of those who saw the efforts which Continental nations were making to surpass us, as they could only hope to surpass a nation possessing vast natural advantages, by organizing the Technical Education of their artisans, and by giving to the sons of the wealthier commercial classes and employers of labor that sound Scientific training which alone could qualify them to use to the highest advantage the Technical training given to the artisans. Scientific and Technical education go hand in hand. Neither is competent alone to bring about that development of the skilled industries which together they can effect. At the first sight it might be supposed that, provided the younger generation of employers of labor possessed a Scientific training, the application of their science to the better Technical training of the artisan would follow as a matter of course. Those who argue thus, leave out of sight one most important link in the chain of cause and effect, viz: That in consequence of slow and almost insensible changes, wrought by social agencies during the last three generations, apprenticeship no longer exists except in name. All that was best and most valuable in the old system of apprenticeship as we inherited it from our forefathers of the middle ages, has vanished, leaving behind it as the inheritor of its name and of its legal prestige a system in which only its worst and least advantageous features are retained. The life of the apprentice in the bosom of his master's family, the pride of the master in his craft, the secrets of trade perpetuated only by being handed down within the narrow circle of the craftsmen of the guild —all these vanished from the moment when the capitalist replaced the master-craftsman as the employer of apprentice labor, leaving behind little more than the petty tyrannies and the subservience to obsolete rules of thumb which degrade so may workshops even of the present day."

The most effective agency that has yet been created to meet this want, and one that promises to give London, if administered in connection with the Science and Art Department, one of the best in the world, is the

"City and Guilds of London Institute,"

comprising a great central institution at South Kensington (under the direction of Sir Philip Magnus) with branches and affiliated institutions throughout the country, and with an elaborate system of local technological examinations. Its aims and work are practical as well as theoretical, and it seems likely to bear the same relation to the extension of Manual Training, that the Science and Art Department does to theoretical teaching. If any friendly criticism is to be made upon it, it is that the Central Institution has begun its work upon a plane too far above the level of present public opinion. It would, however, be a serious calamity if the work so well begun should, for any reason, be allowed to fail of the purposes of its promoters."

The object of the *Central Institution* is to give to London a college for the higher Technical Education, in which advanced instruction shall be provided in those kinds of knowledge which bear upon the different branches of industry, whether manufactures or arts.

The main purpose of the instruction given in this institution is to point out the application of different branches of Science to various manufacturing industries.

In order that this instruction may be efficiently carried out, the Institution, in addition to the lecture-theatres and class-rooms, is fitted

with laboratories, drawing offices and workshops; and opportunities are afforded for the prosecution of original research with the object of the more thorough training of the students, and for the elucidation of the theory of industrial processes.

The courses of instruction are arranged to suit the requirements of—

1. Persons who are training to become technical teachers.

2. Persons who are preparing to enter engineering or architects' offices, or manufacturing works.

3. Persons who desire to acquaint themselves with the scientific principles underlying the particular branch of industry in which they are engaged.

Students intending to go through a complete course of Technical instruction, with the view of subsequently obtaining a Diploma in the engineering, physical or chemical department, are required to pass an entrance or matriculation examination, which includes elementary, pure and applied mathematics, mechanical drawing, physics, chemistry and French or German.

The complete course of instruction involves instruction in all four departments, and is practically the same, during the first year, for all students. It is specialized in the second year, according the particular branch of industrial work in which the student expects to be engaged; and, in the third year, the student devotes himself almost exclusively to the work of the department in which he enters.

The fees for the complete course of instruction to be pursued by a matriculated student are £25 per annum, payable in advance, or £26 payable in three instalments of £12, £8 and £6 at the commencement of each term.

In the case of students who have already gained a considerable knowledge of any particular subject, the course of instruction for the Diploma may be modified at the discretion of the Board of Studies.

Any person may attend parts of the regular courses if he satisfies the professors that he possesses sufficient knowledge to follow the instruction.

The following courses of lectures, forming part of the complete courses for matriculated students, are given during the session, and are open, on payment of the fees indicated, to all persons who may be qualified to attend them :

Mechanics and mathematics.

Mechanism and the application of dynamics to practical problems, the strength of materials, etc., hydraulics.

Engineering.

Surveying.

Practical Physics.

Electrical Technology.

The Chemistry of fermentation and putrefaction.

Crystallography.

The Chemistry of oils (mineral and vegetable) and fats.

The Chemistry of dyes.

With the view to assist in the introduction into the public elemen-

tary and other schools of Manual Training and of improved methods of Science teaching, the following courses of instruction, adapted to the requirements of teachers, are being given:

1. Carpentry and joinery.
2. Experimental Physics.

Summer courses of lectures and laboratory work for teachers and others are given during the month of July:

1. On the Mechanics of construction.
2. On Chemistry, with special reference to the requirements of architects, builders and engineers.
3. On the testing of dynamos and motors.
4. On Graphical Statics.
5. On methods of determining the fundamental standards of electrical measurements.
6. On gas manufacture.
7. On the technology of cellulose and paper manufacture.
8. On lighting, warming and ventilation.
9. On style and styles in building.

Among affiliated institutions, we have space for only a brief notice of

The Finsbury Technical College,

which is conducted with a degree of energy and intelligence that are already bearing fruit in an overcrowding of students, and in the hearty support of the managers of industrial works in its neighborhood.

It was opened on the 19th day of February, 1883, and was erected at a cost of about £36,000, to serve as a model Trade School for the instruction of artisans, and of other persons preparing for intermediate posts in industrial works.

It consists of a school of applied Science and Art. There is a day and an evening school. The latter provides systematic instruction for those who are engaged in the staple industries of the district, including cabinetmaking; and in the application of chemistry, mechanics and physics to special trades, such as spirit rectification, mechanical engineering, electric lighting, etc.

An approach has been made to the establishment of a relationship between this College and the principal middle class schools of the Metropolis, by the award to selected pupils from these schools of exhibitions enabling them, without payment of fees, to receive in the College Scientific and Technical training, fitting them for various occupations and industries, as well as for higher Technical instruction.

The subjects taught comprise mathematics, pure and applied, practical mechanics, chemistry, physics, electrical technology, freehand, model and machine drawing, workshop practice, French and German; and, in the evening, additional classes are held in carpentry and joinery, metal plate work, bricklaying, drawing, painting, modeling and design.

The Polytechnic Institute.

There is one other London institution of a type so nearly unique that a full description would be interesting, possibly somewhat more from a moral and social point of view than with reference to the requirements of systematic education, though it has a manifest claim to distinction on the latter ground. It is known as the Polytechnic Institute, situated in the heart of London, with 3,000 students actually engaged in its courses of study and 7,000 more enrolled in its various sections, attended almost entirely by young men and women who are employed in daily toil, and supported by the large-minded generosity of a single man, Mr. Quintin Hogg, at an annual expense (over receipts) of from $30,000 to $35,000. From the smallest beginnings it has grown to be a great moral and educational force which is now attracting public attention and has won the warm approval of such eminent men as Lord Hartington, Lord Selborne, Sir Lyon Playfair, Mr. Mundella and others. Without detailing the numerous courses of literary and technical instruction, we can best present a general view of the work of the Institute, by quoting portions of a descriptive account which appeared in the *London Times*, April 23, 1888, as follows:

The success of the venture has been astonishing. More than 10,000 boys and young men have their names upon its books, and already the second house has 800 young women upon its list, most of them the sisters or the friends of the members of the Institute. The cost of maintenance amounts to between £14.000 and £15,000 a year; the receipts from fees to about £9,000, and the deficit, which thus amounts to between £5,000 and £6,000 a year, has been, till now, entirely met by Mr. Quintin Hogg. * * * The visitor who makes his way thither between seven and ten o'clock on any week day evening will find every room occupied by numbers of lads and young men, from seventeen years old upwards, either harmlessly amusing themselves or studying in class. There is a refreshment and reading room, where some boys are having tea or supper, some are reading the newspapers, some are playing chess or draughts. * * * Of one great room most ingeniously varied use is made—in the summer it is a swimming bath; in the other seasons of the year, comfortably carpeted and arranged with chairs and tables, it is made into the chief reading room of the place. In another room on certain days in the month, you may see some fifty nicely dressed and rather shy looking lads seated at long tables at their tea, while some senior friends entertain them with music or with talk. These are the "new fellows," who are thus allowed to enter the great world of the Polytechnic in a pleasant way, which robs them very soon of all feeling of strangeness, and enables them to fortify themselves with friends. Indeed, very admirable and special provision is made for the reception of new members; three of the seniors are appointed "new members' secretaries," and it is the business of one or other of them to be present every evening in a certain room, there to receive any new member who desires information, or who prefers to spend his evening out of the crowd. Passing into another room we find a debating society in full work, a young man on his legs stumbling through a speech on the Irish question, or declaring for or against Church and State. In a large hall close by * * * a certain number of youths, unfortunately not very many, are going through military drill. In the other and still larger hall a much gayer sight is to be seen, for here the gymnastic instructor, a color sergeant in the Guards, is taking his numerous and energetic class through

their exercises. From 50 to 100 lads are there, most of them in flannels, and are forgetting the workshop and the counter in the physical delight of exercise. The evening winds up with the performance, to the music of a band, of a sort of rapid figure dance, as complicated and as pretty to the eye as the famous equestrian dance in which Ascanius led the young Trojans in Virgil. Perhaps, after this is over, if the visitor is in high favor with the authorities, he will be allowed to see some of the prize winners perform on the parallel bars or on the trapeze; and it is no exaggeration to say that nothing that the University gymnasiums can show can at all compete with or approach the skill of these young men, these auctioneers' clerks, these tailors, these carpenters of London. * * *

Gymnasium and recreation rooms, however, are not beyond the scope of many other Institutes to be found in London and the country. What differentiates the Polytechnic from all others is the elaborate system of technical instruction which is open to its members. These members, it may here be said, are admitted on payment of a subscription of 3*s.* per quarter, which entitles them to the free use of the library, social rooms, gymnasiums, etc., and admission to all the entertainments, while, for the technical classes, small fees have to be paid. The classes are of two kinds, science and art clssses, which are held in connection with the Department at South Kensington; and industrial classes, which are independent, but which are more or less informally related to the City and Guilds of London Institute of Technical Instruction and also to the London Trades Council. The industrial classes, again, are sub-divided into classes of mechanics and into "practical trade classes" for apprentices and young workmen, and it is these last which are the special feature of the Institute. Among them we find classes for various branches of engineering, for cabinet-making and carpentry, including such subordinate departments as the making of staircases and hand railing; we find classes in wood and stone carving, in tailor's cutting, in sign-writing and in practical watch and clock making; classes in carriage building, in printing, in land surveying and leveling, in plumbing and tool-making and many other trades. In all these cases it is a condition that no one is to be admitted who is not already engaged, say as an apprentice, in the trade, for the managers of the Institute see how important it is that they should not incur the hostility of the London artisan organizations by turning out imperfectly trained and amateurish workmen to compete with them in the market. The wonder is that young men can be found who care to spend their evenings in doing much the same work as that they have been employed upon all day; but such unquestionably is the case, and the class rooms are well filled with lads making engines, carving wood, shaping bricks, or learning the best method of cutting out cloth. They are led partly by the genuine desire of learning, and partly by the wish to better themselves; for example, a young plasterer, who as yet knows only the plainer elements of his craft, comes to the Polytechnic to learn modeling and cornice molding, and when he has learnt his lesson, he, perhaps, emigrates to America and finds himself able to earn something like four times the wages which he had been earning as a simple plasterer in London. In the engineering room, where there is a certain amount of machinery worked by a central gas engine, a dozen young men may be seen profoundly interesting themselves in the forming of a screw, or in adapting some roughly-cast bolt to the required purpose, and the room is full of iron lathes and other small machines, every detail of which has been made and finished on the spot by the boys.

The variety of the classes is very great indeed. Here are a few of the announcements made at the beginning of the last term, and it should be premised that the fees for the classes vary from 2*s.* 6*d.* to 10*s.* 6*d.* per quarter to members of the Institute, non-members being allowed to attend on payment of an increased fee. Mr. H. J. Spooner lectures on geometry and machine drawing, Mr. L. J. Butler on carriage building, Mr. Andrew Clark, F. R. C. S., on first aid to the injured, Mr. Hasluck on elocution, Mr. Herrmann on watch and clock making, Messrs. Horton and Wilson on short hand writing, Mr. E. R. Alexander on printing, Mr. H. L. Ramsey on sign writing, Mr. George Scarman on upholstery, cutting and draping, Messrs. Charles Mitchell and Young on building construction, Mr. H. W. Richards on brick cutting, and in the ladies' department Mrs. Elliott Scrivener on dressmaking and dress cut-

ting. The results are eminently satisfactory, if we can judge from the success of the Polytechnic pupils in the different technical examinations, for they almost always stand at the head.

The work of the Polytechnic Institute has been very favorably judged by those most competent to form an opinion upon it. It has obtained the approval of the London Trades' Council and of two Royal Commissions, and has been commended in the most encouraging way by the Commissioners of City Charities. The London Trades' Council on April 10, 1883, passed the following resolution: "That the system of trade teaching adopted at the Polytechnic Institute be recommended to the London trades." Three months later the same council resolved that—"In the opinion of this delegate meeting of trades, any system of technical, scientific, or theoretic instruction for our industrial population should be accompanied by practical teaching by competent trade teachers, based upon workshop practice, in harmony with the requirements of ordinary business pursuits, similar to the trade instruction given at the Polytechnic Institute." More recently Mr. Woodall, M. P., a member of the Royal Commission on Technical Education, said that "he had, in connection with the Royal Commission, visited nearly all the technical training schools on the Continent and he could safely say that he had not seen one in which such a thoroughly practical system was followed as in the Polytechnic Institute." * * *

As we have said at the outset, the need for technical education is one which is every day becoming more present to the public mind. Our commercial prosperity is being threatened by competition all over the world, and assuredly it will be impossible for us to keep our markets unless our workmen succeed in putting themselves on a level with the best workmen in Berlin, Paris or Philadelphia. The way to this result is through technical education, and this, like every other kind of education, whether for high or low, cannot be self-supporting. If Oxford and Cambridge, Eton and Winchester, flourish by means of endowments; if every elementary school in England is kept at work by means of subsidies from the government, from the ratepayers, or from private subscribers, it is not surprising that technical schools should require help of the same kind. * * *

Messrs. Mather and Platt's Workshop School (Manchester).

[From the Report of the Royal Commissioners.]

Under the guidance of Mr. Mather, the Commissioners inspected the school room and examined specimens of the students' drawings there exhibited.

Mr. Mather stated that there are 68 scholars in the school, which is designed to provide science teaching for the apprentices employed in the works. No strangers are admitted. The drawings are of work actually in progress in the foundry. The teacher lectures upon them and explains and makes calculations, and the lads next day at the works see the very thing they have heard about here. They are allowed to go through the shops in all directions with the teacher from time to time.

For the purpose of practical illustrations from work in process of construction, patterns, models and details of machines are brought into the school from the workshops. The great feature is that technical instruction is imparted by the aid of objects being actually con-

structed in the workshops under the observation of the apprentices, and which are manufactured for sale. The parts of machines which are brought to the school for class instruction are seen by the students afterwards in their proper places in the whole machines.

(*Chairman.*) Can you give us your opinion as to the best method of combining instruction with actual experience in the workshop?

Undoubtedly the school should be part of the workshop, and form a department in which the apprentice must be compelled to serve a portion of his time every week after the ordinary hours in the workshop as a condition of his apprenticeship. A school incorporated thus in the workshops affords facilities for the acquiring of technical knowledge which no science school of the ordinary kind, apart from workshop practice, can possibly offer. The teachers here are draughtsmen in our own works, duly qualified, who by this teaching add to their ordinary income. Schools of this character are simple and inexpensive, and such as every large employer can establish.

Chairman (*to Mr. Jones, the teacher*). Do we understand that the students make sketches from the objects themselves, or that they avail themselves of diagrams?

Sometimes from the pattern, sometimes from the object itself in the works, and sometimes from diagrams which I prepare of objects which are being made in the works. Where we have the sketches we have the patterns here, and sometimes ask the students to measure the patterns and see whether there are any mistakes in the dimensions.

The diagrams are not allowed to be copied?

No. The drawings have to be made to a different scale. The drawings serve only to give the student a general idea of what the thing is like, the students have to work from the dimensions given.

Do they make sections also?

Yes, they make sections of everything. There are in the sketches two views, and they have to make a third deduced from the two.

You let them make a view, either a section or elevation, which is not shown at all in the drawing, and which they have to devise from what is on the sheet?

Yes. [Mr. Jones then exhibited a pattern and stated that he considered it an advantage to make the boys work to scale from the pattern as it teaches them to understand pattern making and molding as well.]

These are patterns of casts actually made in the works?

Yes. The use of this collection of patterns is to show how the whole objects are cast with the use of cores, and it forms a part of our course of machine construction and applied mechanics. The pattern and the finished object are here placed together, so that the student can see the mode in which the finished cylinder is to be cast from the pattern by the use of the cores.

Do you think that the South Kensington models are behind the time?

No, I think that the models for the illustration of geometry are very good. We have never had that collection. We have never made application for it. With respect to coloring and finishing, I consider this a sort of luxury, and it must not be indulged in until the scholars can draw details well and understand them. This is the reverse of the practice followed in the ordinary schools. [Examples were shown of a student's work done in the class, where he had drawn incorrectly a bolt and nut in a plummer block; by the side of this drawing was placed one of a marine engine, colored and shaded, which he was supposed to have done three or four years previously at a high class boarding school. Since he became a student of the works class he has shown no ability whatever as a draughtsman; he had been repeatedly shown the correct method of drawing a bolt and nut.]

(*Mr. Swire Smith.*) How many nights a week do the students come?

Two nights. Three hours on Monday, principally for lectures on applied mechanics, steam and engineering. [Handed in to the Secretary copies of class examination papers and other papers.] I have tested examinations once a session. Out of 28 students in applied mechanics, I passed at the last examination 12 first class and 12 second class.

(*Chairman.*) Will you allow me to ask you what your own education has been?

I was educated at Peter Street School till 11 years of age. Then worked at the bench as a photographic instrument maker. I attended the Salford Working Men's College, learning drawing and mathematics at night, and obtained the gold medal there for geometry. This institution is similar to the Mechanics' Institution, but smaller. The Secretary asked me to attempt the teachers' examination and after I had passed the examination I was induced to take a class by the agent of the Union of Lancashire and Cheshire Institutes. I have now been teaching 17 years. I taught at various institutions about Lancashire and Cheshire, until I found that under the South Kensington system of payment by results you cannot live by teaching alone, so I had to do something else in addition.

You are now employed as a draughtsman by Messrs. Mather & Platt, and you are remunerated for the instruction given here by the grant from the Science and Art Department and the class fees?

Yes.

It has been alleged that there is no great inducement to take the upper Standards, and that to pass students in the lower stage is more remunerative than to pass advanced and honors students. What is your experience?

My experience is that the elementary stage is the only one that pays for the labor expended.

Therefore, there is a tendency on the part of teachers to cast off those who have passed in the elementary stage, and to bring forward a fresh set of students?

Yes, that is the tendency of the present system. The honors stage is purely honor, both to student and teacher, and does not pay at all. In the last year I passed two in honors in geometry.

In your case this tendency is counteracted by a sense of duty to the firm?

I confess I never felt this tendency, not from any sense of duty to the firm particularly, but from a sense of duty to the earnest student. I feel proud to teach an honors student, and am at the present time teaching about 12 such students.

What is the advantage of the students being persons employed in the works, and being trained here rather than in science classes?

The advantage is that I know what each person is working at every day, and have the opportunity of pointing out something connected with the work he is doing. I make the teaching have an actual bearing on his every day work. The students are rewarded not only for proficiency in drawing but for regular attendance, and actual proficiency in their manual work. It is also a condition of employment that they should be regular in their attendance here.

(*Chairman to Mr Mather.*) What advantage have the works derived from the establishment of these schools?

An incalculable advantage. We have to send out abroad yearly one, two or more thoroughly competent men, who shall not be simply mechanics in the ordinary sense of the word, but who shall be able to turn their attention to any kind of mechanical work coming within their duties, whether they have done the work before or not. We had the greatest difficulty in finding such men, until we began to take them from this school, and since the school has been established we have been able to send boys at 20 to 21 to long distances from England, and to place in their hands work which they have not had much to do with before, and by their own intelligence they have made competent teachers of others, and given the greatest satisfaction. We have had cases of students not yet of age holding positions with wages at £4 ($20) per week.

Do you apprentice your young boys?

We do not legally apprentice them. We have only their promise. They are earning wages all the time.

Do you find that they become good workmen at an earlier age because of their training in the school?

Undoubtedly. Little as I come into contact with the various individuals in the works, I have seen during the last few years a vast improvement in all the work these young fellows do, and more re-

sponsible work can be given them. Lads at 17 and 18 have work which before we would not have given to men under 25.

(*Mr. Woodall.*) Is this resented by the other mechanics?

Not in the least.

Do you employ a large number of men who are members of the Amalgamated Society of Engineers?

They are almost entirely so.

And they show no jealousy in any way of the systems you adopt, either of tuition or of giving early employment to boys when they are fit for putting on good jobs?

On the contrary, they seem to like it, and are pleased at the lads' progress.

Can you say the same with respect to the trades generally that are employed in your works?

Yes.

(*To Mr. Jones.*) Do you find that the foremen have any jealousy of you as a teacher?

There is no jealousy whatever. They are always ready to give me assistance as a teacher.

(*Professor Roscoe* to *Mr. Mather.*) Are you aware of any other works in the neighborhood of Manchester, or even in Lancashire, where this teaching method is adopted?

I do not know of any.

The Commissioners were then conducted over the works by Mr. Mather, and the chairman obtained the following statement from Mr. Thorp, general manager.

(*Chairman.*) What is the effect upon your workshop of the training which your boys receive in the school?

(*Mr. Thorp.*) Instead of requiring draughtsmen to look after every separate job, the young fellows who are growing up now, can make their own drawings, make their own patterns, and fit them together and erect them, where it used to require a separate man for each department. The men are most intelligent, and understand and can execute their work much better at a much earlier age. We form thus our own foremen from the boys who have been in the school. We do not find any dissatisfaction or awkwardness with the trade union.

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We shall be glad to hear any evidence you have to give on the subject?

May I first mention the branches of trade with regard to which I desire to speak? I am thinking especially of designers for pottery, for woven and for printed textile fabrics, and for what is known as art metal work. In all these businesses recourse is constantly had by designers to organic form. We find both in ancient work and in work of our own day, that designs consist mainly of re-

productions and of combinations of the lines of organic form, especially of plant form, but often also of animal form. Now, the people of our large towns who form the majority of our population are evidently living under great disadvantage, as they have no beautiful organic forms before them, in their early years when taste is formed, when intellectual habits are created also, they very rarely see any of those beautiful forms which, throughout all ages, have been reproduced in design. Of course we know that not simply the familiarity with organic forms which the eye gains by resting on them is needed for training the taste and giving the knowledge which can afterwards be used for making designs, but that the eye must also be made perceptive of beauty of form. The Art Museum, on behalf of whose committee I have asked to be allowed to give evidence, sees the immense difficulties our people labor under, and it is trying to meet them in this way: it proposes to lend to every primary school in Manchester and Salford, and to every Sunday school, collections on loan of the best representations which can be got of those natural objects which the people of towns have opportunities of seeing on their occasional visits to the country, and, if they choose, to cultivate plants which they have before them in their own houses. The committee do this, because they are convinced that observation of art and observation of nature are constantly interactive; that if you train a child to look with attention and with pleasure on the representation of any flower, when it sees that flower it will look at it with far more pleasure and closer attention than it would have done if its attention had never been brought to the representation of the flower; and, after seeing with interest any natural object, it will look with increased attention at the picture when it is again asked to attend to that. The committee is forming collections of representations not only of flowers and the foliage of flowering plants and trees, and of the different grasses, but also of the animals, birds and insects which are to be found in this country. They give special attention to the commoner plants and the commoner animals, because these are, of course, the kinds the children have the most frequent opportunities of seeing. They have found the greatest difficulty in meeting with representations at once accurate and beautiful, and they believe it is very desirable that, under Government supervision and with Government aid, collections of drawings of the kind I refer to should be formed and offered, either at cost price or less than cost price, to the promoters of art museums and picture galleries throughout the country, and, independently of these, to the managers of schools.

Manual Instruction in the Manchester Board Schools.

The board have arranged to give instruction in the use of tools in two schools.

Lancasterian Board School.

Sharp Street Board School.

For this purpose tools, etc., have been purchased to the following amounts:

	£.	s.	d.	
Benches,	22	0	0	
Set of tools,	22	16	4	
Lathes,	24	0	0	
	68	16	4	(about $340).

Two boys work at each bench. The boys in standard IV and upwards work 1½ hours each per week. A lesson on timber and tools is given once a week to the boys, who work collectively. The cost of timber for the past three months has been about £2 ($10).

A joiner in the employ of the Board superintends the boys at work, and a special teacher gives the lesson.

The work takes place at the latter part of each day, and takes a portion of the ordinary school time.

The boys like the work very much, and the parents appear to be interested. Cases have occurred in which boys have brought special wood to make special things for home.

The Board have also sent £140 ($700) to Paris for the special purchase of models for the machine construction classes, and accepted a special tender for models to be made for the classes in building construction last winter.

It is proposed in September next to commence all the Art classes conducted by the Board, and those in machine construction, on the plan of those in Paris.

A new Art room is in process of erection at the Deansgate school, and this will, *I believe*, be fitted up on the model of the Parisian art schools.

The School Board, at the Science and Art examinations now being conducted, have applied for 3,073 papers in Art and Science for the use of the pupils of their various classes in the town. I may also add, that in the estimates of the expenditure for the year 1883–1884, an amount was specially put down for manual instruction.

In practical chemistry the Board have 271 pupils sitting in May.

South Corporation Industrial Schools.

The Commissioners visited these schools in the course of the afternoon. These schools have been established under Lord Sandon's

Education Act, with the object of providing a suitable education and training for the very lowest class of children, whom it is found impossible to make attend the ordinary Board school. The children are admitted from 6 o'clock in the morning and are kept till 6 o'clock in the evening. They are subjected to a good course of elementary education, but a portion of their time is utilized in the teaching of some useful occupation, and they are fed plainly, but well, during their attendance in school. There are 200 children in daily attendance, about equally divided as to sex. In cases where parents have means, they are required to pay for the food and education of their children. The food costs about 1*s.* 6*d.* (about 37 cents) per week per child, and each child receives three meals per day. Many of the children have neither shoes nor stockings, and a large proportion are in rags. It would be difficult to find a similar number of children, seemingly more depraved or destitute. The children are examined each morning when they come to the school. There are warm and cold baths on the premises in which they are subjected to a cleansing process, when necessary, and their clothes frequently requires to be disinfected.

There are two skilled workmen who superintend the industrial operations, such as the making of door mats, etc., and who also seek up the children when absent. Under the discipline of the excellent matron and her staff, the children make marvelous progress in their school work, and in general civilization. They like the school as is testified by the fact that 95 per cent of those on the register are in average attendance.

Owens College (Victoria University).

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I will only state here that two clear principles have been kept in view by us all along—(1) that a sound knowledge of principles ought to precede this practical application; and (2) that in teaching the applications we shall not aim at superseding that practical training which can only be gained in the manufactory or the workshop. We do not see any reason to doubt the soundness of these principles, and, so far as our experience goes, no difficulty need be found in drawing the line between those applications which may, and those which may not, be with advantage introduced into our instruction,

On the one hand we believe that, so far as the absence of endowments for this special object has allowed, we have been able to contribute important services to our district by way of sending out a number of well instructed young chemists and engineers, and on the other hand that we have not suffered from the danger, which was not unreasonably anticipated by many, that the strictly scientific character of our teaching in these branches might be sacrificed to the needs, or fancied needs, of students that came to us to study Science with an

eye mainly to its application. To illustrate my meaning I will venture to say that no chemical laboratory in the kingdom has sent out a larger number than ours has sent of young chemists, qualified to take important parts in factories and chemical works, and yet it will, I think, be admitted that our laboratory has also not been unsuccessful in the contributions it has made to the progress of chemistry as a pure science—contributions, too, not by the professor and lecturers only, but by not a few of its students of chemistry who are under training.

IV. RUSSIA.

EXTRACTS FROM NOTES ON TECHNICAL EDUCATION, IN 1884.

By WILLIAM MATHER.

[From the Report of the Royal Commissioners, Vol. III.]

Russia differs from all other European countries in not possessing some national system of elementary education. This may be accounted for by the institution of serfdom, which, up to 1860, excluded what we should call the "working classes" from all rights beyond those accorded to them at the pleasures of their owners. Education in the most elementary form may, here and there, have been given in the villages by the priests if the proprietors permitted or encouraged it. In the towns no provision whatever was made by the authorities for the education of the laboring classes previous to the emancipation.

On the other hand, the Government has for many years paid considerable attention to the formation of educational institutions for the families of military and civil officials, the professional classes, and all grades of the nobility. To such institutions the sons of merchants have also been admitted, but the latter have had to depend chiefly on private tutors, and largely upon the advantages offered in other countries, or in Finland, the Baltic provinces, and Poland, which are politically parts of Russia, but retain to some extent their own social institutions, and have long possessed greater facilities for general education, in proportion to the population, than those existing in Russia proper.

In such towns as St. Petersburg, Moscow, Tver, Tula, Kharkof, Kief, Kazan, Saratof and Odessa, Colleges (Real-schulen) and Gymnasia have long existed, and in some of them also Universities. There are not more than 20 towns in Russia proper having over 50,000 inhabitants, and not more than 150 having over 10,000. The urban population is extremely small compared with the whole number of inhabitants. Exact statistics are not easily obtained, but it is within the mark to state that not more than 10,000,000 out of a total population of about 80,000,000 dwell in what we should designate "towns," using this term in its narrowest sense.

The rest of the population is spread over a vast territory, in small communities, pursuing rural occupations under conditions of agriculture and the holding of land, since the emancipation, which will yield enough, with something to spare in the most fertile districts, to those peasants who are frugal and thrifty. Notwithstanding that all

the serfs received a grant of land with their freedom about 22 years ago, the inferior quality, or the want of means to improve it, has made it impossible, in a great number of cases, for the peasants to wholly maintain their families in their own communes or villages. Hence there is a great deal of migration, the heads of families move in search of employment to long distances, leaving children to the care, or neglect, of their relations. The parents will even separate one from the other, and live hundreds of miles apart from Easter to Easter when all work ceases for one week to a month, among handicraftsmen and in all kinds of manufactories, and family reunions take place amid the religious festivals of the Russian Church.

These migratory habits are on the increase since the extension of the railway system.

The only education at present available in the villages is a certain amount of instruction which it is the duty of the village priest to impart, but over which there is no control. There is no village where a priest is not stationed or a church does not exist. Sometimes a group of little hamlets a mile or two apart will have a church and one school in common. The priests are generally men of very meagre education, with large families, and a small quantity of land which they have to till, often with their own hands, to secure a livelihood

It will readily be seen that such conditions are not favorable to education, even in the narrowest sense of the word. Some children acquire reading and writing imperfectly if they are naturally bright, but as there is no systematic superintendence of public instruction on the part of any authorities, the masses of the people are still growing up in ignorance, and the vice of intemperance is one of the most painful results of it.

There are, however, some indications of improvement, which I must mention.

The reforms following upon the emancipation of the serfs included a system of communal government in the villages, the establishing of county boards of jurisdiction in the rural districts, and the extension of municipal institions in the towns. * * * *

Whenever in a certain locality the people themselves have taken an interest in these new institutions, and worked them well, a marked change has been made in the educational facilities of the place. I have been the guest of the mayor of a small town in the interior of Russia, who, at the time of my visit, was deeply engaged in the building of what promised to be a remarkably good school. It was the work of the municipality, with some assistance from the county board, and was intended to be a high school with a small manual training department attached. There is no reason why all towns should not have done likewise, and some may have done so. I have personal experience of the influence which a few enlightened men can now exercise when they take the trouble to avail themselves of

the representative institutions which give the power to administer local affairs. The apathy, however, manifested by the public generally in making the utmost use of the powers granted by the Government is not encouraging. The sense of personal responsibility is doubtless of slow growth in a country subject to autocratic rule for centuries, even when local self-government is permitted. Hence the question of public instruction has not yet become a matter of sufficient interest to move the municipal bodies to establish common schools in any considerable number in the towns. The mother city of Russia, Moscow, is lamentably short of such schools, though there is a great wealth in the community, and an enormous trade is carried on in this central market of the Empire.

Of what we should call "school age," say from 5 to 13, there must be about 100,000 children in Moscow requiring a common school education. I could only obtain a record of 55 such schools altogether, provided by the municipality, giving accommodation for about 7,000 scholars.* Two-thirds of these are from the very poor classes. These schools are small and all overcrowded. The course of instruction comprises religion (as taught by the Orthodox church), reading, writing, arithmetic, grammar, history and geography. These schools are for both sexes. The girls preponderate, but they leave earlier than the boys, generally when they have some knowledge of reading and writing; the boys remain longer as a rule, with the hope of obtaining some reduction in the time of compulsory military service if they can pass certain examinations.

Apart from these schools, the only opportunity for the poorest classes is in a few charity schools, or, when they go to work, in some of the manufactories in and around Moscow, in connection with which there are (with few exceptions) good elementary schools.† This provision is entirely voluntary, and the time allowed for the children to attend school during working hours will vary according to the benevolence of the mill owners and manufacturers. It is the custom to work all textile manufactories throughout Russia, excepting in the district of St. Petersburg, night and day, with two sets of workpeople in relays, working six hours each. During the day leisure (from 6 o'clock A. M. to 12 o'clock) the children attend school and get such recreation as they may care to take. In the evening leisure (from 6 P. M. to midnight) they sleep. It is a hard life, and not conducive to their studying even the simple lessons put before them.

There has been hitherto no law in operation in Russia to prevent the employment of children of tender years. I have seen, not unfrequently, children of not more than seven or eight years of age working equal hours with adults. Happily a law has at length been

*About 24 new schools are to be erected shortly by the municipality.

†In some manufactories there are workshops, or manual training schools, and schools of design. The names of Messieurs T. S. Morozoff, A. Baranboff, Malutin and Prohoroff are worthy of special notice in connection with this useful work.

passed to alter this state of things, and during the course of this year it will come into operation. It enacts that no children shall be employed under 10 years of age, and when 10, only for a limited number of hours per day, until they reach the age of 14. * *

The number of work people engaged in the textile industries is a very small proportion of the entire population. There are probably about 400 establishments, comprising cotton, linen, and woolen mills, and bleaching, dyeing, and print works, etc. The number of people employed will vary from 50 to 10,000. There are many manufactories giving employment to over 5,000 people, and one or two employ upwards of 10,000 people. The aggregate number of workpeople engaged in such industries must be under 400,000, of whom a considerable proportion are children. * * * * *

Taking the country as a whole, the mechanical arts and industrial pursuits, as distinct from agricultural occupations, are comparatively insignificant, and the resources of the country hitherto developed do not offer great facilities for such occupations. There has, however, been a good deal of ambition shown on the part of the Government, to encourage by artificial means, mechanical and manufacturing skill. The two great Imperial Technical Schools of Moscow and St. Petersburg have long been classed among the finest in Europe in point of equipment and in possessing ample means. * * *

(a) The Imperial Technical School of Moscow.

The object of this school is to train civil engineers, mechanical engineers, draughtsmen and foremen, and chemists. The complete course of studies is a combination of theory and practice. The theoretical studies are carried on in large class-rooms amply supplied with all necessary apparatus for illustration. The practical lessons are given by means of manual work in workshop classes, specially arranged for exercise in the use of hand-tools, followed by the construction of simple machines, or parts of machines, in the workshop proper, comprising foundry, smithy, machine-tool and fitting department, and joiners' shop. The products of the workshop are sold or put into the museum. There is a loss of some hundreds of pounds a year on the sales.

The foundry is probably the only department which pays its expenses, and here 25 regular workmen are employed to instruct students and make castings. About eight tons of metal a week can be turned out in castings. In all departments a few regular workmen are constantly employed.

The students enter at 18 to 20 years of age, having first to pass an examination or furnish certificates of qualification from other schools. The complete course of studies occupies six years; it extends to seven years for those who have not been duly qualified before applying for

admission, and who avail themselves of a preparatory course of one year. For the first three years all regular students pass through the same studies, after which a separation is made between the students of engineering and of chemistry, forming two divisions of the school.

The practical work in the shops includes the use of hand-tools, working in wood, making patterns, turning of metals in foot lathes, in which exercise students must pass an examination before they can enter the workshop proper, and take part in the construction of machines. It is generally the fourth year before students reach this stage. * * * * * * * *

The students work in the shops and laboratories not less than 12 hours a week. The smithy and foundry are not entered by students until the last year of the course, during which 100 hours are devoted to these departments. There is a special course for students who, for want of the natural ability to pursue theoretical studies, cannot get beyond the examinations of the third or fourth year, but who may nevertheless possess the practical and constructive faculty. The work given to the special class is all of the most practical character; such as the making of working drawings and full-sized drawings of parts of machines, making experiments on materials, working longer hours in the shops, and generally devoting their time to the application to practical construction of the knowledge they have gained in the more elementary branches of science. * * * *

In the workshops about 280 students are at work for some portion of each day. The time is divided between machine-tools and hand-tools. The manufactured articles consist of simple pumps, water and steam valves, boiler fittings, screw presses, etc. * * *

The school accommodates about 600 students, one-half are boarders, of whom about 200 pay the full fee of £45 a year (present exchange), the remainder are day students paying £15 a year.

The endowment of the school, chiefly from the imperial family, is large, amounting to about £400,000.

The income is about £34,000 a year and exceeds the expenditure. A large staff of professors, teachers and instructors—all Russian subjects—conduct the studies. The premises occupy several acres of land, and the position renders the school easily accessible from all parts of the city.

This institution has deservedly attracted a great deal of attention throughout Europe and in America, owing to the importance of its aims and purposes, the ample means it has always enjoyed to carry them out, and the length of time it has existed. The results, however, cannot be considered satisfactory from a practical point of view. The school has had no strongly marked effects upon the development of civil or mechanical engineering or of manufacturing industry in the last 25 years, during which Russia has extended her railway system enormously and has established what manufacturing industries

she possesses. The presence of foreigners in almost all the important positions on railways, in workshops, in mills and print works, etc., some of whom have had but little theoretical scientific training, proves that even with the laudable patriotic desire to employ native talent in responsible positions it has not been found profitable to do so.

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There appear to be two fundamental mistakes in the management of this institution.

First, the full course extends over too long a period, and the studies are of too theoretical a character.

Second, The students enter at too advanced an age and leave only when they are fully developed men of 25 years old, under the urgent necessity of making a living anyhow, and by age and circumstances unable to take employment as improvers in industrial establishments before recommending themselves as competent engineers for any class of work. The result of this is that they often bring discredit on their training. * * * * * *

The Government has done its utmost to encourage the young men from this institution, by showing greater preference for them than for foreigners, when it is at all possible to use their services. This year an instruction has gone round to all the Government workshops, on railways and elsewhere, that not a single manager or foreman must be employed who is not, or will not become, a Russian subject.

(b) The Technological Institute.

This institution occupies a central position in the city. The buildings cover an area of about 10,000 square yards, and are three stories high. In addition there are large open spaces and detached workshops. 700 students are in daily attendance. The class-rooms are large, each giving accommodation for 100 students, the workshops are very extensive, and the museum, model room, chemical and physical laboratories, are most complete. There are technical laboratories for the bleaching, dyeing and printing of textile fabrics, for papermaking, and sugarmaking. They are all supplied with small working plant for the use of the students.

The schools were established in 1828, under the care of the then Minister of Finance. In the early days boys were entered at 13, and could not enter after 15 years of age. The whole course was for six years, and those who passed successfully were exempt from military service. In 1832 the present extensive buildings were erected. In 1866, a society was formed for the purpose of finding situations for successful students. In 1870, another society was formed for the pecuniary assistance of the students. In 1875, a change was made in the rules of the institution, requiring boys to pass an examination

before entrance, which altered the character of the institution, and raised the age at which students could enter up to 18 years. In 1875, there were 900 students in attendance, of whom 300 were free. During the 56 years of its existence the school has undergone many changes, and the results have varied as the management was more or less efficient. At the present time, under the direction of Professor Iline, it enjoys a high reputation in Russia, and every place is occupied. Besides the president, there are 16 professors, and 32 teachers, exclusive of the instructors in the workshops.

One half the students only pay £5 a year. About 150 are free. The total income in fees from students is only £2,500 a year. The total expenditure is £25,000. The students are admitted without regard to nationality or religion, but are required to pass an entrance examination, or to bring certificates from a *Real* school or Gymnasium. The whole course extends over five years, and is divided into four classes, the fifth year being devoted entirely to workshop practice. All students pass through the same subjects for the first three years, when a selection is made between the mechanical course and the course for technical chemistry; the latter course forming two parts, the so-called "Mechanical and chemical divisions." If, after the second year, students are found to be mentally unfitted to advance into the higher classes, they are dismissed the school, or they may enter the workshops as apprentices for a four years' training as workmen. There are at present 30 apprentices in the institution.

There is accommodation in the workshops for about 100 students. Only a few articles are manufactured in the shops for sale, the value of which is not more than £100 a year.

The subjects taught in the *First Course* are as follows:

Mathematics, geometry, differential calculus, integral calculus, algebra, plane and solid geometry, physics, the expansion of solid bodies possessed of specific gravity, pneumatics, theoretical mechanics, statics, mechanical motions, freehand and mechanical drawing, theory of shadows and perspective, inorganic chemistry.

Second Course.—Physics, laws of gases, steam, theory of heat, theory of resistance in bodies, elasticity and tenacity, tensile and breaking strains, tempering test, ductility of plates, determination of strength of various substances, deflection under given strains, inorganic chemistry. Minerals and and their tests: details of machines, bolts, screws, keys, cones, drums, pulleys, fly-wheels; applied mechanics, friction and adhesion. Mechanical powers, pulleys, levers, endless screws and wedges. Mechanical appliances, parallel motion, reciprocating and rotary motions. Laws of hydrostatic pressure, turbines, water-mills, wind-mills, steam engines, locomotive and gas engines, injectors, pumps, presses, valves, governors. The art of building, and materials for building. Earthworks, stone-work (natural and concrete), wood-work, plaster, cement, paint and glass. Architecture, as a science and as an art; its history and styles. Parts of buildings, foundations, roofs, fire-proofing, arches, staircases and domes. Land surveying, technical and architectural drawing. Calculations, theoretical mechanics, geology and mineralogy.

During the first and second course about 10 hours a week are devoted by all students to drawing.

Third Course.—Mechanical theory of heat, construction of steam engines, details and working of all the parts of land and marine engines. Technology of metals, cast and wrought-iron and steel. Theory and construction of boilers, fuel, heating

surface and fire-grate areas. Construction of chimneys, generation of steam, explosions, hydrostatics. Hydraulic motors and hydraulic lifts. Theory and construction of cranes. Measurement of heat and steam, saturated steam, superheated steam and condensation. Mechanical projection. Analytical chemistry, organic chemistry, chemical technology of mineral bodies. Acids and alkalies. Anatomy and physiology of plants. Technical chemistry. Laboratory work. Technology of organic bodies.

Fourth Course.—Technology of fibrous substances. Manufacture of cotton and cotton fabrics. Grinding corn. Construction of wind-mills (mechanical and chemical divisions). Theory and instruction in heating and ventilating buildings (mechanical and chemical divisions). Theory and construction of locomotives (mechanical division only). Theory and construction of machines used in the manufacture of iron. Blowing engines, steam hammers. Rolling mills, shearing, punching and riveting machines. Machine tools. Qualities of cast iron. Different modes of melting cast iron. Molding, machine construction, designs of steam boilers with chimney, steam engines, water wheels and turbines. Technology of organic bodies (chemical division only). Oils, tallow, tar, soap, bones and their use. Technology of nutritious substances, starch, sugar and potatoes. Preparation of sugar from beef-root. Technology of coloring matters, preparation of colors. Machines used for bleaching, dyeing and printing. Technical plans of manufactories.

The object of making technical plans in the fourth course of the chemical division is to acquaint the students with the buildings and appliances necessary to carry out processes in which chemistry is largely required. Each student has to work out the plans in detail of one of the following manufactures. Manufacture of sulphuric acid, glass, soda-ash, porcelain, etc.

Fifth Course.—This is devoted to the preparation of plans, full-sized working drawings, and practical work in the machine shops, foundry, smithy, joiners' shop and in the practical laboratories for dyeing, bleaching and printing, etc.

The students of the mechanical division give six hours a week to constructional drawing and eight hours a week to the designing and drawing of manufactories. In the former they have to design bridges, trusses, and study the computation of strains, arches, roofs, columns, etc. In the latter they are required to prepare plans for machine shops, forges, foundries, sawmills and water works. In the workshops they have to learn the use of tools, filing, turning, planing, screw-cutting, molding, smith-work and joinery. At the end of the fifth course each student is expected to construct some piece of mechanism. Sample machine tools by the best makers in Europe are placed in the mechanics' shop for the instruction of the students. Special instruction in the tending of steam engines and boilers is given in the last year In the chemical division students are engaged in the purification of petroleum, of vegetable, animal and mineral oils; gas manufacture from coal, wood and naphtha, making drawings of the buildings required and the different kinds of furnaces and appliances. They have to make researches in the statistics of raw material, imports and exports. A special course of electricity and its practical application has been recently established, but it is optional with the students to undertake it.

Looking over the statistics of this school, it would appear that from 70 to 100 students graduate after the full five years' course each year. There has been steady improvement in the preparation of the students in the *Real* schools and the Gymnasia. The number of those who

have left of their own accord, or who were sent away in consequence of being unfit to pursue the studies beyond the second class, is from 10 to 15 per cent. each year. About two-thirds of the students appear to be capable of being transferred to the higher classes from year to year.

It is claimed for this institution that a large proportion of the graduates succeed in finding good positions in the Government service, the railways, and in some of the large manufactories of the country. Mr. Asaph Baranoff, of Moscow, who has had special opportunities of judging of the results produced by the two institutions of Moscow and St. Petersburg, considers that the training of the St. Petersburg school, so far as chemistry is concerned, is highly efficient for experimental purposes. I met a considerable number of young men, who were formerly students of the St. Petersburg Technical School, in several of the large turkey-red dye-works around Moscow, yet very rarely have I met with a graduate of either of these schools holding a responsible position in a calico printworks, of which there are upwards of 50 in the country. I attribute this want of practical success on the part of the young men in both the mechanical and chemical industries to the fact that the pursuit of theoretical science is over-strained, and beyond the requirements of the country at the present time. The singular dependency of Russia upon the practical knowledge and aptitude of foreigners proves that there is but a very limited field for the use of these theoretically trained men who leave the technical schools at 25 years of age. I believe the training in both institutions in theoretical science to be sound and thorough, but it is more suited to a country highly developed in all its resources than to one like Russia, almost wholly agricultural, and with manufacturing industry confined to the simpler applications of the mechanical arts.

(c) The Handicraft and Industrial School.

This is an institution possessing a very fine building, recently erected at a cost of about £45,000. The school was promoted by some of the members of the Imperial family, together with the town authorities and private individuals. Its object is to educate and train boys of poor parents who are deserving of assistance (and for orphans) in the mechanic arts. It also receives a number of boys who are paid for, either by their parents or friends. The boys enter at 12 years of age and remain until they are 17. They receive a sound elementary education in the following subjects: Reading, writing, arithmetic, the Russian language, history, geography, natural history, elementary chemistry, mechanics, and physics, technology of metals and wood, free-hand drawing, mechanical projection, singing and gymnastics. The practical work consists of joinery, bootmaking, engraving, paper-

hanging, smiths' work, turning, planing and shaping of metals, and various articles in ironmongery are manufactured. They sell about £600 worth in value of such articles per year. There are 300 boys who are lodged, boarded and clothed in the institution. About 20 youths leave each year who have no difficulty in finding immediately occupation in workshops where they receive about 12*s*. per week. The course of instruction extends over five years. In the first two years they spend two hours in the workshops and five hours in the classes; in the third and fourth years four and a half hours in the workshops and five in the classes. In the fifth year the whole day is spent in the workshops.

The Girls' Department of the same institution is conducted by a head-mistress, two scripture teachers, four teachers, two instructors, one science teacher and nine teachers of handicrafts. In the girls' department a similar elementary education is given. Girls are admitted from 10 to 12 years of age and remain until they are 17. A considerable number of girls pay for their education, or their friends pay for them, to admit them into this institution; the amount of the fee charged is £15 a year for full residence. Semi-boarders pay £6 a year and daily scholars £3 a year. Besides receiving an ordinary elementary education, the girls are taught the cutting out of clothing, all kinds of needlework, dressmaking and millinery, lacemaking, housekeeping and cooking. The girls of the highest class take in turn the management of the household. The united expenditure of this institution last year was £16,000, including some new apparatus and tools. The total assets of the institution amount to £78,000.

V. SWEDEN.

[NOTE.—In 1883 the Belgian Minister of Public Instruction sent Messrs. Sluys and Van Kalken to Sweden to study the organization of manual instruction in that country. Upon their return, Mr. Sluys presented a report to the minister. Shortly after, the Ministry of Public Instruction was abolished by the clerical majority which had secured possession of the Parliament, and the report was not given to the public. In 1885, however, Mr. Sluys himself published it under the title: "Instruction in Manual Work in Primary Schools for Boys." Of this report the Commission has translated or condensed the following very considerable portions, partly because the observations and conclusions of Mr. Sluys are entitled to great weight, as those of an experienced and highly successful normal school principal, and partly because Sweden, better than any other country, has solved the difficult problem of combining a varied manual training with the ordinary work of the ungraded rural school.]

In many countries of Europe, in the United States and in Japan, the movement, which gains in force from year to year, is manifesting itself in favor of the introduction of manual training into the primary schools for boys. The educational press and the political press is actively occupied with this question, especially in Sweden, Finland, Norway, Germany, Denmark, Holland, France, Italy, Switzerland, Austria, Russia, etc., and Belgium has not remained foreign to the movement. Special journals have been established in Germany and in Sweden to propagate the idea. The subject has left the domain of theory, and in a certain number of primary schools in Sweden, Finland, Germany and France instruction has been given for some years in manual training.

This movement deserves to be attentively studied. In tends, in fact, to introduce into school organization a new element, which will profoundly modify the existing character of the popular school. When we seek the origin of the efforts made in this direction, we find a very marked divergence of view among the promoters of the idea.

If we eliminate details of minor importance, we may reduce to two general systems all the theoretical and practical forms which the question of primary instruction in manual work has taken: The economic system and the pedagogic system. One party placing itself at the purely economic point of view, holds that the primary school should aim essentially to awaken and reveal aptitudes; to develop them and to prepare children as completely as possible for the various trades, so as to assure them on leaving the school, or soon after, the material means of existence. They believe that the creative forces of social

wealth would thus be largely increased. The partisans of the pedagogic system regard manual labor as a means of education adapted to give skill to the hand and a general aptitude for the diverse circumstances of practical life, and equally adapted to excite a taste for labor and to exercise vigorously the faculties of attention, perception and intuition.

The contrast between these two tendencies is complete. For the one, the aim of primary instruction is direct preparation for professions or trades; for the other it is more elevated and more general; the school should form the complete man; should develop systematically and harmoniously all the faculties of the child without attempting to prepare him for a given occupation. The first transforms the class-room into a school of apprenticeship and annexes the school to the work-shop; the other preserves for it its essentially pedagogic character by organizing manual labor in it according to the general principles which control all primary instruction.

It is important to study each of these two systems by referring to what has been done in Sweden, where they have reached practical solutions.

1. The Economic System.

The principal considerations advanced by the partisans of the economic system deserve to be rapidly set forth.

The great majority of children in all civilized countries are destined to become industrial or agricultural workmen, living from day to day upon wages painfully earned. The sub primary and the primary school take possession of them and hold them under their discipline from three years of age to twelve or fourteen, and during this long period give them an instruction which is in direct relation to the occupations which they are to engage in. As a whole, this instruction is almost the same as that given to the sons of the *burgeois*, although the latter are, in general, destined to a wholly different kind of life. They will not have to engage in manual labor to secure their existence. They will become lawyers, physicians, professors, merchants, manufacturers, etc. The children of workmen and peasants learn to read, to write, to cipher; they are taught the first elements of history, of geography, of the natural sciences, drawing, singing, etc., but they are not subjected in the primary school to a course of training adapted to prepare them for the manual occupations which they will have to exercise during their whole life. They will have to work in wood, in stone, in metals, by means of various tools, and their hand is never specially exercised with this aim, for one can attach no importance, in this respect, to the handling of pen and pencil during lessons in writing and drawing. Gymnastics itself is useless in this respect. It strengthens the muscles, increases the physical energy and the moral energy, but hardly develops at all the technical aptitude.

During all the school period, boys who are destined to the rude life of the workman acquire sedentary habits. They are obliged by the theoretical exercises of the school to remain sitting before a desk five or six hours every day. This position enervates their bodies and is little adapted to inspire in children a taste for manual exercises. Hence, when the critical moment arrives for choosing an occupation, this son of a farmer or of a workingman is greatly perplexed He feels himself hardly fitted for any trade whatever. His aptitudes have not been awakened by the course of training to which he has been subjected; often, in fact, he feels an unconquerable aversion to all manual labor. The condition of his father does not greatly attract him. He has seen only its hard and disagreeable features. The father himself does not advise him too strongly, for he does not cease to repeat that if he were to begin life over again he would not choose an occupation so difficult, so wearisome and so poorly paid. In general, this boy, if he has profited well by the purely theoretical studies of the school, desires to engage in a career in keeping with the life which he has spent up to this time. He desires to enter the normal school or the seminary, or perhaps he dreams of spending his life in an office. These sedentary employments fall in with the habits acquired at school better than any trade whatever. The parents, proud of the success of their son, hope to see him acquire a brilliant position—thanks to his talents, which they imagine to be altogether exceptional because they are incapable of appreciating them. They decide to make every sacrifice in order that their son may acquire the knowledge necessary to attain the position so much envied. Agriculture and manual work are thus continually deserted by the most intelligent sons of workmen and peasants. Most of them find the employments filled, and swell the crowded ranks of the declassed; constitute in the bosom of our society a species of literary proletariat more to be lamented than the industrial proletariat.

As for the child of the people who, on leaving the primary school, has not received instruction enough to venture to entertain these lofty views, he is hesitating when he ought to decide upon a choice. He no longer cares to ask himself what is his calling—what are his aptitudes? he is guided by wholly different considerations. Frequently his parents choose for him, although they have only very rarely any precise notion of that for which he is adapted. He enters then as an apprentice. He is loaded with difficult tasks—to clean the shop, to blow the bellows of the forge, to do errands. During many years the young apprentice receives no regular, methodical, technical instruction. But, if he does not learn his business, he acquires, in contact with the workmen, habits which certainly do not always exercise a good influence on his morality. Fortunate is he if he can still, after the fatigues of the day, follow for an hour or two the lessons in the adult schools,

which will keep up and develop what he has learned in the primary school.

After some years of this irrational apprenticeship he knows his trade but imperfectly. He is a half workman; his wages are small, and he runs great risk of remaining at that stage unless he is unusually gifted. Many young people give up their first attempts, change their trade again and again, never succeed in completing their apprenticeships, and end by resigning themselves to be messengers, agents, clerks, domestics, etc. The want of a methodical organization of apprenticeship to the trades is thus the cause of an immense loss of productive force. Thus, then, the partisans of the economic system conclude: On the one hand, the primary school does not inspire the taste for manual labor, and does not develop technical aptitudes; and on the other hand, apprenticeship in shops is given over to chance, and produces scarcely any good results. Is it surprising that, under such conditions, accomplished workmen become more and more rare and that agriculture makes so little practical progress?

In order to remedy this situation, to elevate national labor, to put a check upon the desertion of manual and agricultural occupations by the sons of workmen and peasants, to diminish as far as possible the number of the declassed, it is necessary to reorganize the public school —to give it a more practical character; to introduce into it the teaching of trades; in a word, to establish there a course of training which shall closely unite general studies and industrial exercises.

Such are the conclusions which those reach who place themselves especially at the economic point of view in the discussion of the proper character of popular instruction.

In his interesting work upon technical instruction, Senator Corbon, after having eloquently set forth the actual defects of apprenticeship in the shops and their deplorable consequences for the working classes, in the material, intellectual and moral point of view, concludes in favor of the organization of technical instruction, beginning with the primary school.

"I believe," says he, "that every primary communal school ought to enlarge the circle of its instruction and become, like the Martiniere,* a technical school. It would give to industry so many skilled workmen.

"The extension of the primary school of which I speak would be an easy thing for rural schools. The teacher, in most cases, would suffice for the work, and the increased expense would be almost nothing. In cities, and for preparation for the different industrial trades, the modification would be much more expensive, but not so much so that it ought to alarm any one.

"In the city school the teacher can hardly do more than instruct

* A well-known technical school at Lyons, named for the founder, Mr. Martin.

his classes. There would be needed, I suppose, as many teachers of manual exercises as of primary classes, but no more.

"There would be needed one shop at least as large as the class-room, and furthermore, a court or some ground. In the shop there would be a forge, with anvil, hammers, vises, files, etc.—that is to say whatever is indispensable for the making of certain simple products in iron. It would be necessary, also, to have some lathes and carpenters' benches with the accessory tools. In the court there would be some blocks of stone to cut and re-cut until they were used up.

"If the school has ground enough, it would be well to reserve a part of it, and accustom the children to garden it. It is evident that the teacher, however intelligent and active he may be, could not be at the same time at the forge, the lathe, the bench—in the shop and in the court, where the little stone-cutters, the boys with wheelbarrows or the gardeners are working, doing everything at the same time; but the difficulty would be relieved by the appointment of corporals and sub officers—chosen by the pupils from among themselves."

This utilitarian conception of the school has naturally found numerous partisans, at a time when industrial labor has received enormous development and when questions relating to workingmen have become the object of general attention.

There is a serious foundation of truth in the acute criticism upon the actual organization of popular education which we have just quoted. It is necessary, however, to recognize that it is greatly exaggerated. Those who maintain it place themselves too exclusively at a single point of view. They require that primary instruction should have for its principal object the direct preparation for the manual trades, and they think that the only means of arriving at this result is to attach workshops of apprenticeship to the school. But the true mission of primary instruction is more general, more elevated It should develop the child in all his faculties and his aptitudes; should form the man and the citizen, and not the carpenter, the blacksmith, the trader or the employé.

Even from the special point of view of preparation for the manual occupations, it is certain that a rational course is pursued in teaching children to read, to write, to cipher; in opening their intelligence and developing it by exercises of observation upon things lying in the domain of nature, the arts and industries; in teaching them drawing and geometrical forms; in submitting them to a moral regime, and in increasing their general energy by gymnastics. It is indisputable that children who have successfully followed the complete courses of a well organized primary school, are better fitted to learn any trade whatever quickly and well, than those who have been left to stagnate in ignorance, or who have been sent too early into the shops, the mines, the factories—where their health is weakened at the same time that their intelligence is stupefied.

It is not just, then, to accuse the primary school indiscriminately of being useless in respect to the immediate interests of the popular classes; but it is true to say that it has still too much of a theoretical character, and that it does not develop the technical aptitude. Something is needed, beyond question, to improve and complete its organization, and we are of opinion that the solution of the problem lies in the development of the principles of Froebel's method, which have already entered into our elementary instruction, but which have not yet been carried into every branch of primary instruction. This we shall show further on.

As to the many inconveniences of apprenticeship in the ordinary work-shops, they cannot be denied. They are the fatal consequences of an economic situation, occasioned by the introduction of machinery into industry, and by the division of labor pushed to its extreme limits. It does not enter into the plan of our study to set forth this question in all its details, and to discuss whether it is for the interest of the working classes and of industry to organize a special technical school for boys, independent of primary instruction, and forming a complementary training for children destined to industrial pursuits.

Let us examine whether, in practice, the apprenticeship to trades in the primary school, properly so called, offers important advantages.

At Gothembourg manual instruction is organized in the primary schools with reference to its economic results.

Toward the age of ten or eleven years the children are sent to shops attached to all the primary schools. During the first year they are subject to a course of rotation—that is to say, they are exercised successively in wood working (carpentry, turning, carving), in iron-work (forging, lockmaking), in work with paper and cardboard (binding), with colors (house painting), and with willow (basket-making). More importance is attached, apparently, to the working of iron and wood. At least that is the impression which several visits to the school have left upon us.

The course of the first year has for its sole aim to give to the pupil a first taste for labor; to allow him to ascertain his fitness and his calling, and to choose judiciously the trade which he will definitely adopt. He passes several weeks in each shop and learns to handle the principal tools there, and to perform the elementary works.

The second year he indicates what trade he wishes to learn. If he finds later that he was mistaken in his choice, he can change his first decision and enter another shop; but this case, as we are informed, is very rare.

The apprenticeship is followed until the age of fourteen years.

As a measure of economy the shops are placed in the basement or under the roof. They are very well furnished with tools, air and

light are abundantly supplied, and the general arrangement leaves nothing to be desired.

The technical instruction is intrusted to select workmen.

The lessons are given to groups of twelve, on the average, who, during their work are all under the exclusive direction of the foreman, who is responsible for the order and discipline, and the results.

There is neither method nor programme rigidly determined. The foreman of the shop has no other guide than himself, except, of course, the instructions given by the special inspector of manual work. Thus the succession of exercises is not fixed—in other words, there is no series graduated by models, and constituting a methodical whole. The works to be executed depend upon the requirements made for the needs of the schools. In these shops are made a considerable number of objects utilized in the communal schools, such as chalk boxes, black-boards, counting-frames, iron work for desks, barometers, playthings of wood and of painted metal, tools for the different shops, etc., etc. The products are brought together and exhibited. They are sold or distributed among the schools. The work in the shops takes place twice a week—four hours at a time—for each section of twelve to sixteen scholars. Every year, those who have distinguished themselves by their diligence and progress, receive a reward consisting of tools of the trade in which they are engaging. A sum of 1,000 crowns (about $275), is devoted annually to this distribution of prizes.

During the year 1883 the number of scholars who followed the courses of manual labor in the primary schools rose to 1,776. The total expense was 34,482 crowns, of which 24,105 was paid for salaries, and 10,377 for material and for incidental expenses.

The manufacture of school material and the repairs made in the shops were estimated at 11,232 crowns.

From the fact that the scholars of the different classes of each school go to the shops at different hours, an advantage is gained over the ordinary teaching force; the number of teachers required being less than that for other classes. It is estimated that this annual saving amounts to 6,750 crowns. Taking account of all these elements, the total expense for technical instruction was reduced to 17,233 crowns, or 9.70 crowns per scholar per year.

* * * * The engineer, Mr. Ericson is the organizer and inspector of this instruction. He declared to us that neither employers, nor workmen, nor parents were unfavorable to the introduction into the primary schools of apprenticeship to trades. Those who, at at the outset, thought that this innovation had no practical bearing, have since recognized their error. The pupils who leave school at fourteen years—after three years of apprenticeship—receive, immediately, a small salary from their employers, because they are already able to render some service in the shops.

Although at first view such a system seems to present real

advantages, we do not think it advisable to establish this in our primary schools. In the first place, regarding it even from the economic point of view, it is very incomplete. It would be, in fact, impossible to attach work-shops of apprenticeship to the primary schools for all the trades followed in a given locality. A limit must be placed, a choice made, and then the problem of giving technical instruction in the primary school remains incompletely solved. By rotation it is intended to bring the child to a recognition of its aptitudes ; but, in reality, he is made to run through only two or three special shops, and his choice is narrowly limited.

Moreover, on what principle shall the trades to be taught in the school be selected? Why shall a certain industry be favored rather than another? Is it proposed to transform all the children who attend primary schools into carpenters, or blacksmiths, or basketmakers? The reply to these objections is that a more complete organization would cost enormously ; that, furthermore, when the young man who has learned one trade during three or four years is obliged to undertake another, he makes rapid progress in his new apprenticeship, because he has already acquired the habit and the taste for manual labor. This observation is important, but it favors the pedagogical system. It is, in fact, the habit and the taste for labor which it is necessary to acquire at the primary school, and it is useless to organize for this purpose shops of apprenticeship, properly so called. This result is reached more completely by methodical exercises specially arranged to promote the acquisition of a general aptitude of the hand. This opinion prevails in Sweden, and Mr. Hedlund declared to us that he had been brought to it in consequence of a thorough comparative study of the different systems.

The apprenticeship to a definite trade should be put off until the age of fourteen years at least. Children younger than that are not sufficiently developed physically and intellectually to undertake it with success. What is especially needed in a professional instruction like that of the schools of Gothembourg, is a good pedagogical direction.

These exercises do not follow a methodical order because they are, in general, subordinate to economic considerations foreign to pedagogical principles. From ten to fourteen years a boy is still only a child, and in order that any work whatever may exercise upon him a real educative influence, it is necessary, above all, that he become keenly interested in it, a thing which can be secured only on condition that the exercise be varied, graduated and proportioned to his physical strength. Accordingly, we do not think that by the system of apprenticeship at Gothembourg, sufficient interest can be excited, without which no efforts can obtain satisfactory results. Thus, when a child is obliged to make a given object—iron work, balls for counting-frames, etc.,—a considerable number of times, it is necessary that he go over

the same work incessantly day after day and week after week. After the third or fourth time, his interest disappears; one can see from the manner in which he handles his tools, from his listless air, that he is doing a veritable task, quite similar to that of scholars upon whom it was formerly the custom to impose as a punishment the copying ten or twenty times of the same page of writing, the same verb, or the same lesson. The mechanical repetition of an exercise invariably provokes disgust with the work. It will be said that the workman is obliged, in many trades, to do the same work over again many times, and that it is not a bad thing to make a child acquire the habit of working under the conditions in which he will be placed somewhat later; but a child of school age cannot be treated as an adult workman. The workman must work in order to live; the pupil works in order to develop himself, to acquire the taste and the aptitude for study in general, and for manual skill, and, if the exercise imposed upon him are not graded and varied, he executes his task without pleasure and quits it without success.

Furthermore, it is evident that under these circumstances the pupil is no more skilful for having made the same object ten or twenty times; the second specimen is sometimes better made than the first, but the following ones, instead of showing progress in correctness of execution, are likely to show the contrary.

The study of the method adopted in the Normal School at Naas will show the superiority of the pedagogic system over that of Gothembourg.

2. The School of Naas.

(A system of manual training in schools, based upon the pedagogic idea.)

Naas is an ancient lordship, situated in the district of Elfsborg, near the line of railroad which unites Gothembourg and Stockholm, and about fifty miles from the former. Mr. Abrahamson, on acquiring the property some years ago, founded three free schools, to which he gave an endowment of 225,000 crowns (about $60,000). His purpose was not only to furnish primary instruction to boys and girls of the locality, but also to furnish an example of methodical instruction in manual training, according to the views of the most advanced educators. The primary schools for boys was opened in 1872. It is attended by children from ten to fourteen years, who have already received the first grade of instruction in the primary school. [This instruction, which is obligatory in Sweden, is given in two grades of schools; the elementary schools, for children from six to ten years, and the public schools, for children from ten to fourteen years.] Twenty two hours a week are devoted to instruction in the following branches: religious instruction, the Swedish language, history, geography, the natural sciences, reading, writing, drawing, singing, gymnastics, the manual of arms,

horticulture. [In Sweden, besides gymnastics, military drill and the manual of arms are taught in the schools] Besides, the pupils work two hours every day in the shop. The work is not so directed as to prepare the boys especially for trades. The question here is not at all how to maintain a school of apprenticeship annexed to the primary school. The aim is purely pedagogic; the manual work is made educational as much as the other branches of the programme. The teacher directs it. By the methodical handling of tools, the making of a hundred objects, forming a progressive series, the scholars are made to acquire a skill—a general address of the hand, which renders them fitted, on leaving the school, to undertake, under favorable conditions, the apprenticeship to any trade whatever, and to execute without assistance, works of every kind which present themselves every instant in practical life. Furthermore, this instruction constitutes a vigorous gymnastic, which contributes, with gymnastics properly so called, to re establish in the organism the equilibrium, which is inevitably disturbed to the detriment of the health of body and mind, by studies exclusively intellectual. Finally, it inspires in pupils a taste for labor and develops the faculties of attention and of intuition.

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Sixteen boys, the youngest eleven and the oldest fourteen years and a half, enter the shop. Their joyous air, their unconstrained bearing, show with what pleasure they engage in the work. Each one goes to his bench, takes his tools, examines them, tries them. Each one understands them well, knows how to mount and dismount them, to sharpen them, to repair them in case of need. This one observes that the blade of his plane projects too far; some blows of the hammer, well applied, presently place the tool in its proper condition. Another finds his chisel notched; he goes to the grindstone and sharpens the instrument. We see a third, who is setting his saw; still another carefully cleans the file which he is about to use. The instructor, during this preparatory work, has been distributing the models. The pupils who have a new article to make go, without waiting for directions, to select in the wood room the piece of timber or the plank, of which they are to make a spoon, a stool, a box, a boot-jack, a mallet, a nevette or any other article in the series of models. All have learned by practice to distinguish the qualities of wood. All this is done quickly but without haste and in good order. The spectacle becomes truly interesting. The hatchet strikes the block squarely; the saws grate; the planes gnaw; the knives cut; the files smooth the roughness of surfaces; the sand paper vigorously rubbed upon an article gives it finish. It is the humming swarm of labor, full of life and movement. The teacher does not directly aid the pupils. We see him go from one to another controlling, criticising, correcting, encouraging the little workmen. The strictest discipline reigns in the shop. It maintains itself naturally because it springs

from the labor itself, which exercises upon the pupils a veritable attraction and requires the steady concentration of their attention; a wholesome emulation keeps up activity and assures progress. It is impelled not by desire for a reward but only by the desire to do the best possible; by the satisfaction of performing a duty which is not burdensome because it is proportioned to the strength of each. The scholars have not all the same article to make. In the first place because they do not all begin at the same time, and then because certain pupils advance more rapidly than others on account of their greater attention or skill.

The exercises having been finished the boy presents his work to the director, who examines it attentively and judges whether it is worthy to be accepted or not. If it is well executed the director compliments the pupil who carries home the product of his work. The modest household of his parents will be enriched by a useful object the commercial value of which is very slight but which is highly appreciated because it was made by the boy himself. It is his own work; no one has directly aided in it and he is proud to show it. If, on the other hand, the model is badly produced, and if the mistakes cannot be corrected, the director, after having required the pupil himself to note his faults, breaks it and has it made over again, for every one must do his work in the best possible way. It is not the quantity of articles which is considered important but their quality in point of correct execution.

Mr. Abrahamson founded, in 1874, a primary school for girls. Its object was to give to young girls, from ten to sixteen years, at the same time with ordinary instruction, a sufficient skill in domestic labors belonging to females—such as spinning, weaving, sewing by hand and on the machine, housekeeping, preparation of foods, etc.—in a word, the pupils there are initiated into all the occupations which will be of constant use for the future mother of a family.

In 1884 he introduced into this school a course of working in wood, to the extent of two and a half hours a week.

The instruction continues ten months and a half each year, with eight hours of study and of work every day.

The pupils are divided into two divisions. In the higher class, twenty-four hours a week are devoted to ordinary studies, and ten to manual labors. In the lower class, twenty-one hours a week are given to lessons, and fifteen to domestic works.

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The normal school of manual work (Slöjdlärareseminarium = a seminary for teachers of manual training. Slödj is an expression purely Swedish, which it is impossible to translate exactly into any other language, but which designates, in general, the manual labor proper to schools and domestic work) is an institution unique of its kind. A complete study of its history, its organization, its experi-

ments, the principles it has applied, its methods and its programme, will be, I believe, fruitful in suggestions of every kind upon the important question of primary instruction in manual labor. * *

The normal school was established in June, 1875, and five years later it was enlarged and installed in the building which it now occupies. * * *

The main floor contains on the right two shops. one containing nineteen benches, the other twelve, a lathe, a grindstone, carpenters' tools, turning tools and tools for wood-cutting hang upon the wall in careful order. The left wing is occupied by two class rooms, in which the ordinary instruction is given to the pupils of the primary school. The teachers who follow the courses gather there to listen to lessons in pedagogics, given by Mr. Otto Salomon, and to discuss questions relating to primary instruction in manual work. The desks of this room are in one place, and of a movable pattern—to be raised or lowered, according to the height of the pupils; an arrangement which seems to us an ingenious solution of this important question of school desks.

Beautiful geographical charts, cards representing animals and plants (Deyrolles' collection) ornament the walls. In glass cases are exposed collections of minerals and rocks, geometrical models and other objects serving to give an insight into the subjects taught. Upon the wall facing the pupils are engravings representing the kings of Sweden and some great teachers; in a word, these class rooms have a cheerful aspect The laws of hygiene have been scrupulously observed in their construction, and the teaching apparatus proves that the instruction which is given there is according to the best modern conception of popular schools. The class rooms are connected with the shops by a large corridor, in which pupils assemble at certain hours for lessons in singing, accompanied with instrumental music. The two wings of the building are separated by a grand hall, the museum, which contains models, serving for instruction in manual training, as well as a very large collection of objects of every kind, furniture, tools, toys, etc., which have served as models during the period of experiment.

The method of Naas is not, in fact, the product of pure theory; it is the fruit of a long and serious practical study. The investigations to which Mr. Salomon and his colleague, Mr. Johanson, devoted themselves in order to arrive at the present system of instruction (Slöjd), were pursued during many years, with rare perseverance, and were crowned with success. * * * * * *

During the first years, from 1875 to 1880, the aim of the normal school at Naas was to instruct and to train men capable of teaching manual work in the schools, either independent or annexed to the primary school.

The conditions of admission were as follows: To be at least eighteen years of age; to have a sufficient physical strength to perform the duties for which the school prepared; to have already some practice in manual work, and to know the subjects required in Sweden at the examination for leaving the primary schools.

The instruction comprised two parts; one theoretical or general, the other practical. In the first was arithmetic, geometry, physics, mechanics, linear drawing, pedagogy, the science of methods; in the other the practice of trades, such as the execution of works designed to teach a knowledge of the various tools of the carpenter, the turner, the wood engraver, the blacksmith; familiarization with the handling of these tools; the making and repairing of the simplest tools and utensils of an ordinary household; the making of shafts and wheels for carts and wagons; working with large tools, and working with the file.

The course continued one year at the rate of fifty-four hours a week, of which thirty-six were employed in manual work, and eighteen in the scientific studies.

Those who followed this course were practiced in giving special instruction in manual labor by teaching pupils every day in the primary school, which forms the school of application (model school), and the examination for graduation included three tests—one upon theoretical branches, one in linear drawing and the work of the shop, the third a teaching test in the school of application. A diploma was given to the candidates who successfully passed the examination.

In 1880 this organization was modified; the theoretical courses were suppressed; the instruction was concentrated in the exclusive study of manual training. Since that time the school no longer trains special professors, unless in exceptional cases. It receives by preference primary teachers holding a diploma, who wish to acquire a practical knowledge necessary to teach the Slöjd in the schools where they are employed. This change is the consequence of the purely pedagogical character of the method of Naas.

Manual labor, not being considered as a direct preparation for specific trades, but as an educational agency, it does not form a special branch of the general programme, and the teacher gives lessons in that to his pupils as he teaches them to read, to write, to cipher, etc. Mr. Salomon thinks that the true mission of the primary school is the systematic cultivation of the faculties; that the different branches of instruction should be considered as the means proper to attain this end. No one branch, then, can tend to specialization; all must be grouped in a harmonious whole, and the fundamental condition for attaining this result is to require the same teacher to give the pupils of the same class instruction in the whole programme.

According to this conception there can be no question of applying to the primary school the principle of division of labor, since, in spite

of the apparent diversity of subjects which are taught, primary education forms a single indivisible whole. The system of special teachers is in contradiction with the aim of the primary school.

The consequence of this system is the necessity of preparing teachers to give instruction in manual training. It is this rôle that is assigned to the normal school of Naas. It is open to all teachers who desire to introduce this instruction into their schools. The courses and the lodging are gratuitous. The teachers take their meals in a restaurant attached to the school at the rate of one crown (about twenty-eight cents) a day. In general the Swedish teachers who follow the courses receive, for their traveling expenses, assistance from "Economic Societies," which are associations created to encourage all works having in view the moral and material well-being of the people.

Within a few years, this subject has made important progress in Sweden. There are to-day (1885), about seven hundred schools in which the Slöjd is taught. The teachers do not everywhere give these courses, their necessary preparation being defective; but the general tendency is towards this result. Although the official programme of the normal schools and the primary schools does not yet prescribe instruction in manual training, the Swedish government is interesting itself in the subject, and many of the teachers of the country are moving voluntarily to introduce this instruction into their schools.

Since 1878 many teachers have informed themselves respecting the method of Naas. The temporary normal course continues six weeks, and the review course in the following year five weeks. In general these two courses are sufficient to exercise the teachers in the correct making of the hundred models of the series, if they continue to perfect themselves in the handling of tools during the year which intervenes between the two courses.

As in Sweden the vacations do not take place at the same time for all the schools, many temporary courses are carried on at Naas each year.

The following table will give an idea of the activity displayed in this institution and of the progress which the idea is making in Sweden.

In 1878, fourteen teachers were prepared for instruction in the Slöjd.

In 1879, nine teachers were prepared for instruction in the Slöjd.

In 1880, thirteen teachers were prepared.

In 1881, eighteen teachers.

In 1882, one hundred and two (in six temporary courses).

In 1883, one hundred and fourteen (in six temporary courses).

In 1884, one hundred and thirteen (in five temporary courses).

To these numbers there should be added two teachers who followed the course only in part, and more than sixty professors, engaged in teaching manual training in schools whose regular teachers cannot give this course on account of their age or for some other reason.

Not all these teachers belong to the Swedish nationality. At Naas the narrow spirit of exclusivism is unknown. The object there is to promote general progress. Thus, in 1884, among the one hundred and twenty-six persons who followed the course, there were one hundred and seven Swedes, two Norwegians, four Finlanders (three of whom were females), one Dane, two Germans, five Austrians, two Russians, two English ladies, one Hollander. Among these were one hundred and eight primary teachers, the director of a school of deaf mutes, three female teachers, two school directresses, three school directors, two professors of secondary schools, an inspector of primary schools, and an inspector of Slöjd.

When one sees that a private school has been able in so few years to give a vigorous impulse to the primary teaching of manual training, it may be hoped that governments solicitous for the development of popular instruction, will not hesitate to put forth energetic efforts in order to give a practical and general solution to this question.

We followed, with eighteen Swedish teachers and one Finnish teacher, the temporary normal course which was given from the 15th of August to the 21st of September, 1883. These teachers were classed in two divisions, one of which included those who were following the review course. The labor in the shop was carried on six hours every day, under the direction of Mr. Salomon. Mr. Johanson and others gave the courses. The history of pedagogy and the methodology of manual training were taught by Mr. Salomon, who besides presided at the conferences, in which the teachers freely discussed the system set forth, their doubts, their criticisms, etc.

These discussions were recorded by one of the teachers.

Each morning and evening, immediately before and after the work, the teachers gathered to recite a prayer and chant psalms, each one being free to take part in this religious exercise or not.

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The 21st of September, 1883, the course was terminated by a formal session. In the two shops the models made by the teachers were arranged on the benches; the walls were hung with the banners of the different provinces of Sweden; outside, the Swedish, Finnish and Belgian standards floated aloft.

After the prayer and psalms Mr. Salomon spoke as follows:

"GENTLEMEN: It is a gratifying spectacle to see men of countries remote from one another, belonging to different peoples, gathered in this little corner of the world to labor in a common work. In this view my heart beats with joy and confidence, for I find here a convincing proof that there are other interests than those which actuate the individual, which unite families, or which constitute the vital forces of nations. It is a proof that there exist interests as wide as humanity, and surely the work of education is one of these interests. If one regards general and constant progress as a necessity of nature,

founded on the will of God, and if one remembers that the future belongs to childhood, it must also be admitted that the impression of one generation upon the following—which is education—is a matter of universal importance. Upon this grand field of labor there can be no question about conditions of nationality. We should, on the contrary, each one for himself, direct our forces toward the common end: The preparation of youth for life upon earth first, and also for the future life, where social inequalities are no longer of any account.

"It is, without doubt, the constantly increasing tendency in the teaching body towards a more rational education, which has brought teachers together here from so many countries.

"More and more the conviction everywhere prevails that the school sins grievously against the principles of a rational education, to the great prejudice of our children. How general this has become is shown by the introduction of manual training in the schools—a system which aims to train the skill and dexterity of the hand, in the same measure as the purely intellectual faculties. The efforts made in this direction are, so to speak, a complete protest against this education which takes a false direction, and which results unquestionably in an instruction purely theoretical, such as is, unfortunately, still too generally given.

"Far be from me the suggestion that this protest has been raised in our little country alone, and that we have been the first to recognize the necessity of the reform which now engages us.

"Does not history teach us that the people being ripe for any reform of which the need is felt, this suddenly appears, and most frequently at the same time in many countries? Surely, then, it is not befitting either an individual or a people to claim the privilege of having been first to possess that which is the common property of humanity.

"This truth being granted in respect to things relatively common, must all the more be admitted in respect to an extremely important idea like the one we are now considering, the extent of which cannot yet be measured, or the consequences fully understood. I desire, as far as my knowledge and my experience permit, to make you understand that the idea of employing manual training as a means of education is not a novelty and innovation; but that, on the contrary, its roots run back to the remotest time. In fact, we have seen that the authors of modern pedagogy have appreciated the highly educative value of this process. It is enough to say that in occupying ourselves seriously with manual training we are not giving our time and our strength to the service of a vain caprice or a fashionable notion."

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In 1846 a Swedish association was established for the purpose of extending the Slöjd. About the same time the well-known writer, Mr. Hedlund, published a number of articles, in which he eloquently

set forth the importance of the subject. It was not until 1872 that the Swedish government gave attention to this interesting method of instruction. The Chamber of Deputies then voted an annual appropriation of 2,500 crowns (about $700,000), which was successively raised to 10,000 crowns, and then to 20,000, for the purpose of encouraging the communes and the teachers who introduced instruction in manual training into the public schools.

In 1875 the Royal Academy charged the engineer, Albert Ramström, with the duty of organizing temporary courses of Slöjd.

In six years 147 courses were given to 1,678 persons, of whom 456 were primary teachers, and 101 special professors.

In 1877 the Chamber of Deputies voted a sum of 15,000 crowns for the support of public schools in which manual training was taught.

The teacher who introduced this branch into his course of instruction received an annual appropriation of seventy-five crowns (about $20).

The first efforts were not very fortunate. Almost everywhere attention was given to wood-carving, an exercise of slight educational value, and a certain degree of opposition was manifested towards the teaching of Slöjd. Happily, a more rational course was followed by other institutions, in which attention was given to more serious work.

The schools of Naas, Upsal, Clæstrop, gave a better example, and exercised a happy influence in the country.

Some figures will show with what rapidity the teaching of Slöjd has advanced in Sweden. In 1876 only eighty schools included this branch in their programme; in 1877 there were one hundred, in 1879 about two hundred, in 1883 about six hundred, and in 1884 more than seven hundred. This constant progress is due in great part to a few men of ability, who have devoted themselves entirely to this cause. The sculptor, Chas. Ahlborn, gave, from 1870 to 1875, about two hundred "conferences" in different parts of Sweden. He explained the subject to more than 60,000 hearers. Count Erick Sparre also made energetic efforts to encourage the movement. * * *

At the outset, the economic conception was generally adopted. Instruction in manual training was everywhere regarded as a means of giving the child of the people a way to earn his bread. But, little by little, the subject assumed its true aspect. It was recognized that manual training has a far more elevated purpose—far more useful, even in the philosophical acceptation of that word. It was regarded as a pedagogical process, adapted to secure more completely the physical, moral and intellectual development of the child. Thus was realized in Sweden the dream of those illustrious educators, Comenius, Rousseau, Pestalozzi and Frœbel, of seeing in schools of primary instruction manual training closely joined with any subjects purely theoretical, in order to secure the integral training of all the faculties and all the aptitudes which constitute the complete man.

3. The Method Pursued at Naas.

If the name of method is given to a well considered and systematic course, leading to a well determined end, the manual training of the school of Naas constitutes a veritable method, and it has an unquestionable character of originality Nothing in this system is left to chance. It is the result of experiments prosecuted for many years with the constant desire of being able to give a practical and effective form to primary instruction in manual training.

Mr. Otto Salomon has departed from the modern conception of the popular school and sought constantly to remain faithful to the fundamental principles of the science of education, respecting which there has been hardly any difference among the great teachers since Montaigne, Comenius, Rousseau, Pestalozzi and Frœbel. We now give a resumé of our conferences with him respecting the principal questions raised regarding the organization of instruction in manual training in the primary school.

(a) *The Necessity and Aim of Instruction in Manual Training in the Public Schools.*

We know by experience that the child has a natural tendency to activity. It shows itself from the time when he begins to be able to use his members. He delights himself by directing his feeble efforts to everything that he can seize upon. He takes the objects nearest to him, handles them, throws them, breaks them; not in a spirit of destructiveness but from the need he has of doing something, and from the instinct of curiosity which is the starting point of all later intellectual acquisitions.

The programmes of primary instruction take too little account of this fact. The lessons are almost all theoretical; they address the intellect only; the hand, which is an admirable instrument designed to give a concrete form to the thought, is not given a special training in primary schools. Writing and drawing are the only branches which call in its aid, but they can develop it only very incompletely; they do not give it a general facility which finds application in the exercise of all professions, all arts, and in many circumstances which are presented by practical life. Gymnastics, properly so called, are of scarcely more account in this respect. They strengthen the muscles but they do not train the technical aptitude of the hand.

The education of the child is incomplete if it has only taught him to think, if it only furnishes him with theoretical ideas. It must develop all his faculties, including manual skill. The child should not receive a preparation exclusively literary and scientific; he should also be prepared for the arts, the trades, the industries—that is to say should be initiated to all the forms of human activity. General manual skill can only be developed by exercises which demand the

methodical handling of numerous tools. The teaching of special trades in the primary school is out of the question. That would be to turn aside the school from its true aim, which is the intregal and harmonious cultivation of the faculties. In the same way as instruction in arithmetic, geometrical matters, drawing, writing, etc., does not propose to prepare pupils for the professions of the engineer, the mathematician, the public officer, the designer, etc., so the primary instruction in manual training does not design to form workmen—carpenters, turners, blacksmiths, etc.

It will be objected that the pupils in the primary school have already enough to do. This is true as respects intellectual work; but it is certain that they are not required to perform any serious manual exercise. Manual work differs wholly, moreover, from intellectual work. The latter has very great value, but the child does not appreciate its necessity. He hardly studies at all for the love of study, or because he perceives the importance of the end to be attained; this end escapes his notice. He learns because he is obliged to learn. Instruction in manual work is altogether different; it pleases the child because he finds in it food for the imperative need of activity which exists in him; he sees the results of his efforts and can appreciate them. Thus, when a young boy learns to conjugate a verb, or to resolve a problem, he does not appreciate, from his point of view, the utility of the efforts which he is required to make; but if he makes a bench, a box, etc., he sees clearly the end to be reached, he understands and appreciates for himself by comparison with the model, whether his work is well or ill done. It is observed also that pupils are much better pleased with the exercises of the shop than with those of the class. For these reasons we may affirm that manual occupations have more educational value than purely intellectual work; they call forth to a high degree the taste and the love for work in general.

They have another consequence which it is important to note; they show constantly to the pupils that work upon material has a great value of its own; they inspire respect for it, and thus remove the too general dislike for manual labor which appears everywhere among the children of the people. The pedagogical organization of instruction in manual work in the primary schools removes one of the causes of the desertion of trades by the children of workmen and peasants. It lessens considerably the time of apprenticeship to a trade. The boy who, for several years, has been exercised in educational manual work has an unquestionable superiority in acquiring rapidly all the practical details and secrets of any occupation whatever. But manual work is necessary also for all pupils, even for those who do not intend to follow trades. Not to develop skill of the hand is to deprive children of an aptitude which is of great importance in practical life, and which is a source of healthful diversions; it is to act with as little

discrimination as if one should not cultivate their memory or any other intellectual faculty.

The child who is trained in the labors of the shop acquires the spirit of order, of correctness; his desire, as experience proves, is to make his article the best possible, and this desire increases with the increase of skill. By constantly comparing his work with the model which he has to imitate he makes note of progress, sees the errors which he commits and corrects them. He feels that without order it is impossible for him to arrive at correct execution. The habit which he acquires in the shop, of working with order and correctness, reacts upon all his other school work.

Every teacher knows that attention is the essential condition of effective study. The child who is distracted learns nothing. Without attention there are neither ideas, nor reflection, nor mental development. A routine work produces inattention, which thus becomes habitual. But there are trades which demand a constant concentration of intelligence upon the work to be executed and which train it to a habit of attention. Work upon material gives, moreover, clearer perceptions of form, of dimensions; it trains insight in the highest degree. Manual occupations well directed sharpen the sense of sight; develop the faculties of attention, of insight, of reflection and exercise the spirit of combination. When the choice of models to be executed has been made with discrimination, manual exercises awaken also the esthetic sentiment and prevent it from becoming perverted. They learn, in fact, to give to raw material an irreproachable form, adapted to the destination of the object fashioned.

In ordinary lessons children remain sitting before their desk during long hours. This position is bad; it enfeebles and enervates the body, and reacts in the same way upon the mind. School gymnastics are maintained for the very purpose of reëstablishing the equilibrium in the organization, through increasing functional energy and consequently moral energy. Manual occupations exercise an analogous influence if they are chosen among those which require the pupil to hold himself erect, and to exert himself vigorously.

We have more than once heard the wish expressed in Sweden that manual labor might be introduced into the secondary and upper schools in order to counteract the consequences of the difficult studies of the young people. [In some secondary and upper schools in Sweden manual training has already been introduced.] It is frightful to dwell upon the disastrous consequences produced by the regime to which more students are subjected who intend to enter the liberal professions. During the first twenty years of their life they exhaust their forces by a very intense intellectual labor. "The result of exclusive special studies has been, and will be more and more," says Mr. H. Leneveux, "a tendency to mental alienation, to enfeeblement and to nervous maladies." The same author indicates manual labor as an

excellent means of securing the regular play of the organs, among those persons who do not belong to the class of workers in material.

Such are the principal general considerations which characterize manual labor in a pedagogical point of view. We resume, then, by saying that it has for its aim:

1. To cause the child to acquire a general skill of hand.
2. To awaken in him the taste and the love of labor.
3. To call forth spontaneity—the initiative.
4. To give him experience of the fact that order and correctness in labor are necessary elements of progress.
5. To develop the faculties of attention and perception.
6. To render the child earnest and persevering.
7. To inspire the esthetic sentiment without allowing it to become vague or exaggerated.
8. To neutralize the injurious effects produced upon the system by intellectual studies, and by the sitting position which the child must maintain during the ordinary lessons.

(b) *The Choice of Manual Occupations.*

The choice of manual exercises to be introduced into the primary school for the purpose of attaining, as completely as possible, the pedagogical end which we have set forth, is not a matter of indifference. It is necessary, in fact, to take account of numerous conditions which affect the question; conditions which are not found combined in most trades. Rousseau, in "Emile," gives emphasis on this point to the considerations which we are about to name, because the most of them tend to the object to be reached.

First. He rejects at the outset "every sedentary and indoor occupation, which effeminates and weakens the body."

The professions of this kind are neither agreeable nor fitting for children. * * * * * * We should then omit at the outset trades like that of the tailor, which cannot develop the general energy of the body.

Second. "I forbid to my pupil unhealthful trades."

Third. "It is necessary, also, to make account of cleanliness. I shall not make of your son a horse-shoer, an iron-worker, a blacksmith; I should not like to see him at the forge in the form of a cyclops; moreover, I shall not make him a mason, still less a shoemaker. It is necessary that all trades be carried on, but whoever is at liberty to make a choice, should have regard to cleanliness, for that is not a matter of opinion; on this point the feeling decides for us."

Almost all children have already too great a propensity to neglect the cares of cleanliness, and even to begrime themselves deliberately. Education should tend constantly to overcome this tendency; for cleanliness is not only necessary in the hygienic point of view, it is almost a virtue; it is closely connected with morality. When one

sees children slovenly, neither washed nor combed, their clothing soiled and ragged, one may be certain that in the family and in the school the spirit of order does not exist; that neglect of duties is there the rule.

Fourth. "Finally, I should not like those stupid occupations, the laborers in which, listlessly and almost automatically, use only their hands at the same round of work—the weavers, the stocking-makers, the stone-cutters. Why should a man of sense engage in these trades? He is one machine that works another!"

Trades of this nature are not appropriate to the primary school. They train manual skill but little, and clog the intelligence instead of awakening it We should exclude all occupations which demand only restricted and, as it were, automatic movements, and especially those in which the work is done by a machine, the duty of the workman being simply to put the raw material in place, and then wait until it is transformed. These occupations have no educational value; they do not keep the attention and the reflection awake; they bring no satisfaction to the child, whom they reduce simply to the watcher of a machine.

Fifth. Division of labor, pushed to the extreme in modern industry, has created a crowd of occupations, in which the workman is no longer a true artisan, transforming raw material into works complete in themselves, and bearing the stamp of his own individuality. The principle of the division of labor is certainly excellent in the economic point of view, since it permits the production of abundance of useful objects at a cheap rate, but it is an error to suppose that an extreme division of labor is favorable to the intellectual development of the workman because it leaves him free to think of something else while his hands are executing very simple movements—always the same—and requiring scarcely any reflection. In reality, routine work produces stupidity; it transforms the workman into a veritable machine, unless he is exceptionally gifted.

The child, as we have already said, cannot find satisfaction except in works the object of which clearly appears to him. To require him to make an article which is to pass through the hands of many other pupils before being completed, is surely to awaken in him a disgust for labor. Under such conditions the responsibility is divided. What cares the pupil whether the piece upon which he is working is correctly executed? It is going to be taken by another, who will make of it what he wishes; as for him, he finishes his task well or ill. What direct interest has he in doing the best possible? If the completed object is defective, he is not concerned—it is not his work. *In the school it is necessary to require the same pupil to give to the raw material a definitive form without the coöperation of any other person, that he may be able to claim the work as his own, and one for which he holds the entire responsibilty.*

The occupation to be chosen, then, should be one which does not demand division of labor, and this condition considerably limits the choice.

Sixth. It is sufficient merely to note the necessity of given to children only such occupations as are proportioned to their physical strength. If too violent efforts are required—too fatiguing—they exhaust and repel; but, if they are too easily executed, if they do not require a sustained attention and do not present increasing difficulties of execution, they do not sufficiently exercise the faculties, or increase the physical vigor, or cultivate a habit of preserverance.

Seventh. On the other hand, the exercises should constitute a progressive series, gradually increasing the difficulties of execution, demanding greater and greater energy and attention, so that each work may be a little more difficult than that which has preceded, and may prepare for that which is to follow. This is the necessary condition for supporting emulation, exciting diligence and perseverance, and assuring the constant progress of the pupil.

Eighth. The nature of the objects to be made by the pupils is a very important question. It touches considerations of a high order, which do not appear at first sight, and in respect to which we must speak more fully.

At Naas all work *de luxe*, work of fancy and diversion, is prohibited. The method requires the making of useful objects, which can be employed in the family of the children attending the school. Their nature is determined by the social position of the parents of the pupils. These belong generally to the agricultural or industrial classes, like the immense majority of those who in all countries attend the public school.

The term "*luxe*" is relative. Many an object considered as useful in the house of a rich townsman, would be out of place in the lowly home of a workman or of a peasant. For these last a luxury is everything which is not directly usable in the household; and we have in view here the education of the children of the most numerous social class, that which lives by manual labor. It is of the highest importance not to cultivate in them a taste for useless trifles. The time which they spend at school is too short, the practical necessities of life too imperious, to permit the expenditure of effort in teaching them to construct articles purely ornamental. This question has moreover, a moral bearing which should fix attention. Experience has proved that children who are taught at the outset to make articles of luxury, experience, in consequence, a great repugnance for labors which are merely indispensable or useful; thus young girls who have commenced by making embroidery, or other works of this kind, think they lower themselves by engaging in the cares of the household, the repair of clothing, the making of ordinary garments, all things which they consider common and unworthy of themselves. In the same way

most of the boys who are taught to make purely ornamental articles, such as little frames, little boxes, and so many other trifles of doubtful taste, from cut wood or card-board, shows nothing but disdain for more serious works. Owing to their ignorance, false notions are instilled into them concerning the aim and the dignity of labor; they come to distinguish common labors (which they look upon as unworthy of themselves) and honorable labors, when, on the other hand, they should be impressed as early as possible with the profound truth that all useful labor is honorable to him who performs it.

We insist upon the importance of this principle because in many civilized countries many children of workmen and of peasants show a strong tendency to despise manual labor; aspire to abandon the condition of their parents and to embrace occupations which they consider far superior, such as those of employés in commercial houses or in public offices.

By organizing a serious teaching of manual work in the public schools, and by excluding severely from the series of occupations those which have no other aim than the gratification of taste or luxury, these children will be inspired with a respect and taste for the useful occupations which their parents followed. We think that the principle above expressed should be applied even in schools attended by children of well-to-do families. They have only too much occasion, in the condition in which they live, to employ themselves with trifling things, and to attach to them an importance which they do not rightfully merit. By requiring them to perform labors really useful, we should counteract, to some extent, the false effects of a domestic education often badly directed.

The question has been raised whether it is desirable to teach children to make toys. This kind of work has been thrown aside for various reasons:

(1.) The instruction in Slöjd is given to children from ten to fifteen years of age. Sons of peasants or of workingmen, they are about to enter upon life, and it is important to prepare them for it; the making of useless and trifling things like toys, would be in contradiction to this aim.

(2.) Toys at this age produce only a brief pleasure.

(3.) Children experience no more pleasure in making toys than in making objects which they carry home, and which are utilized in the household.

(4.) Parents do not esteem the labor which produces only a toy, while they do appreciate useful objects. When the child brings from school an object of this kind, they show their satisfaction, praise and encourage the little workmen. The article is immediately utilized in the family, and serves a long time with a pleasure always new. A toy does not produce this general satisfaction, which is, for the child, a strong stimulus.

At the opening of the primary school at Naas the children were required to make purely ornamental articles and toys. The parents showed themselves altogether unfavorable to this kind of work. They said that their children were required to lose precious time. It became necessary to pay them forty öres a day (about eleven cents) to induce them to send their children to the Slöjd school. After this all objects without practical utility were excluded, and since that time parents take pleasure in seeing their children follow the course of manual work. At the congress of teachers in 1883 this topic was a subject of lively discussion, but the view of Mr. Salomon respecting the nature of the objects to be made in the Slöjd, was almost unanimously approved by the members present.

It may be affirmed that the Slöjd has profoundly rooted itself in the soil of Sweden, only because of its character of immediate utility, which has caused it to be appreciated by the people, and which has, moreover, strictly conformed to the principles of a serious education. Here, still, Rousseau was right in saying, "I wish absolutely that Emil learn a trade. Do you say, 'at least an honorable trade?' What does this word mean? Is not every trade honorable which is useful to the public? I do not wish that he be an embroiderer, or a gilder, or a varnisher, like Locke's gentleman; I would rather have him pave the highway than make flowers on porcelain. Thus, coming back to the first word, let us take an honorable trade; but let us remember always that there is nothing honorable without usefulness."

Ninth. Manual labor should regard the making of objects which develop the esthetic sentinment by their purity of form. This proposition is not opposed to the prohibition of objects of luxury and mere ornament. Useful objects, employed in the household, are susceptible of a certain touch of good taste when they are made with exactness, correctness and neatness.' True beauty is not found in superfluous ornament; it has been rightly said that the beautiful is the splendor of the true.

The searching for ornament exclusively, is characteristic of art in decline; it may be observed in a great number of works are called artistic in our time—monuments, furniture, etc. It is necessary to guard against this with care in primary instruction in general, and particularly in manual training. True beauty resides in harmony and symmetry, which require that every article be perfectly adapted to its use, occupy exactly the necessary space, without having too much or too little of anything—all the parts well balanced and blending in unity. Every useful object, however common it may be, can be made crudely or tastefully. Thus in the composition of the series of models, usefulness will be kept in view with reference to the social rank occupied by the pupil; but the most elegant possible form should always be given to articles. In this way the Slöjd will have a truly educative influence; not only will it develop skill of the hand, accuracy of the

eye, but it will also satisfy the sentiment of the beautiful, while preventing it from going astray or predominating exclusively.

Such are the principles which guided Mr. Salomon in the choice of occupations to introduce into the primary school.

We sum them up by saying that the manual occupations of the primary school should answer the following conditions :

1. They should exercise manual skill as completely as possible ;
2. Should concentrate attention and keep the intelligence alert ;
3. Should accustom to work with order, correctness and neatness ;
4. Should require only the making of objects of general utility ;
5. Should develop the esthetic sentiment without exaggerating or misdirecting it ;
6. Should include the making of complete objects, executed without involving the division of labor ;
7. Should be proportioned to the physical strength of the children ;
8. Should be hygienic, develop the general vigor, and be executed, as far as possible, in a standing position ;
9. Should present a progressive series—that is to say, graduated with reference to difficulty of execution.

In primary schools of manual training, the choice of occupations has been confined, in general, to the following :

1. Iron working : forging, lockmaking.
2. Working in straw and willow : basketmaking.
3. Working in paper and card-board : *cartonnage*, book-binding.
4. Wood-working : turning, sculpture, carpentry, wooden-ware.

The following table indicates, briefly, for each occupation, which of the above-named conditions they satisfy :

	General manual skill.	Attention—intelligence.	Order—correctness, ect.,	Cleanliness.	General utility.	Develops taste.	No division of labor.	Graduated to strength.	Develops general vigor.	Progressive.
Iron-working, . . .	No,	±	±	No,	Limited,	Slight,	No,	Yes,	No, . .	?
Basket-work, . . .	No,	Yes,	Yes,	Yes,	Yes, . .	Yes, . .	No,	No,	Incomplete,	Yes.
Binding, ...	No,	Yes,	Yes,	Yes,	Limited,	Yes, . .	Yes,	No,	No, . .	Limited.
Card-Board work, .	No,	Yes,	Yes,	Yes,	Limited,	Yes, . .	Yes,	No,	No, ...	Yes.
Wood-working, . .	Yes,	Yes,	Yes,	Yes,	Yes, . . .	Yes, . .	Yes,	Yes,	Yes, ...	Yes.
Carving, ...	No,	Yes,	Yes,	Yes,	No. . .	Yes, . .	Yes,	No,	Yes, ...	Yes.
Turning, ...	No,	Yes,	Yes,	Yes,	Yes, . . .	Yes, . .	Yes,	Yes,	Yes, ...	Yes.

Observations on the above Table.

1. Iron-working, forging, lockmaking. Work with the file and the hammer increases the vigor of the arm, but does not exercise the hand in many directions ; it benumbs it, rather.

The apprenticeship is hard and long. The attention is not awakened except in one who already knows the trade quite well, but the beginner works without having this faculty appealed to. Work with

the file is too mechanical; the great hammer of the forge room is too heavy for the child to handle. The articles which pupils from ten to fourteen years can be required to make are rarely of immediate use in the household; the forms are too little varied to exercise the sense of the beautiful.

2. Basketmaking. The fingers alone are effectively exercised; the trade is too poor in tools to allow very varied movements; the children cannot make a complete basket from the beginning—the rim is too dificult to make; the teacher then must take part in completing the work of the scholar. Large baskets require efforts which the child cannot make; the work is done in a sitting posture and does not develop the general vigor of the body.

3. Book binding The general and direct utility of this trade with reference to the pupil and his family, is very limited. Children rarely succeed in binding a book well. At Gothembourg it has been observed that out of sixty six pupils, only two (three per cent.) obtained satisfactory results. A progressive series of exercises in binding is possible, but it is very limited.

4. *Cartonnage.* This work fulfils nearly all the conditions, but is little favorable to the development of physical vigor. It has few application in practical life. It secures flexibility of the fingers; but not enough of the general facility of the hand.

5. Wood-work is the most favorable. Rosseau understood this well. "Everything considered, the trade which I would prefer my pupil to have a taste for, is that of the carpenter. It is clean; it is useful; it can be exercised in the house; it keeps the body sufficiently erect; it requires in the workman skill and industry, and in the form of works which utility determines, elegance and taste are not excluded."

This the conclusion which has been reached at Naas. The Slöjd there includes the making of one hundred household articles in wood. It is not carpentry, properly so-called; it is, rather, a combination of carpentry, of wooden ware, of turning and of carving. The tools are forty-six in number. They comprise the ordinary instruments of carpentry, with the addition of the knife (*wabstrinque*, a curved knife which is employed to hollow out spoons), chisels and gouges for wood turning,

The knife—unknown in carpentry properly so-called—is very much employed in the Slöjd. The Swedish peasants make use of it to cut out a multitude of articles in wood. Their children have use of this instrument long before the age of admission to the shop of the school. Advantage is taken of this preliminary acquisition; the knife is often used in making the models of the series.

Carving and turning occupy, however, only a limited place in this method. They do not sufficiently meet the required conditions. Carving is done in a sitting posture and only requires limited move-

ments of the arm and of the hand; moreover, the time is too short to admit of the pupil occupying himself with many special exercises in carving. It is used, however, to some extent, in order to give to some articles an artistic touch by a very simple ornamentation.

The work in turning is sufficiently hard, and is not without danger. Furthermore, it requires one-sided effort; it cannot, therefore, be allowed a preponderant place in work of the school. In short, wood-working, without carving or turning, is enough for the general end in view.

In their totality, the exercises of the Slöjd give occasion to handle all the tools which are employed in wood-working. To execute all the manipulations proper to this kind of work the pupils learn even to make various kinds of joinings. When they have made the one hundred models, one can say that the pedagogical aim of the Slöjd is completely attained. They have acquired this general facility of the hand which finds so many applications in practical life; and, whatever manual occupation they may choose they accomplish their apprenticeship in it much more rapidly, and they are fitted to follow with success, many trades.

The articles made by the pupils are neither polished nor colored. Experience has shown that children from ten to fifteen years of age do not succeed, in general, in applying color well, or in polishing wood satisfactorily. Another and more important reason tends to favor this prohibition; the child has a natural inclination to conceal the defects of his work, and he succeeds in this by the application of paint or of polish; he gives a passable exterior aspect to an article of doubtful merit; he thus habituates himself not to do his work conscientiously, and comes to attach more importance to that which appears than to that which is. If the objects must be executed in wood, without the use of means to give them a deceptive appearance, he applies all his care to reach the highest possible degree of perfection; he sees at once the defects of his work, and corrects them. Furthermore, it is not true that an object is more beautiful because it is painted or polished; it should be beautiful by its correctness of form and of execution.

It has been objected that a polished household article retains its neatness longer; but even in this point of view it is desirable to do without it; it is necessary to accustom the children to keep the objects which they have made in the neatest possible way.

The pupils can only employ in their work a minimum of material; this is a principle of economy which they are taught to apply in the shop; it is well that this habit be formed from an early age. This material is exclusively wood, because it has been shown that wood working is most suitable, and because it is a common material, easy to procure, and finally because, in general, it is necessary in construc-

tion to limit expenses as far as possible—to make simple objects, to use a single material.

In the series of the hundred models at Naas only a few objects require the employment of any other material, except nails, tacks, hinges, etc. These are, moreover, used in carpentry. The pupils learn to work different kinds of wood—soft and hard. One is quite tempted to think that soft wood lends itself always more readily to the action of tools; practice proves, however, that in many cases it is easier to work hard wood. The use to which some articles are put requires hard wood, others soft. The employment of different kinds of wood allows a better gradation of difficulties.

The great variety of articles of the series is justified by the necessity of always interesting the child in his work. We have already said many times, and the principle is so important that we do not hesitate to repeat it, the pupil who is required to make numerous specimens of any article whatever becomes listless, works without enjoyment, makes no progress. There are found in the series of Naas objects of the same kind—many spoons, many boxes, many bootjacks, etc —but they are not immediately repeated; they present different degrees of difficulty of execution, and the pupil does not pass directly from one to the other.

We insist also on the gradation in the labors of the Slöjd. It is a general principle of pedagogics, that all instruction should proceed from the easy to the difficult; from the simple to the complex; this principle is respected in the series of Naas. It cannot appear clearly to the eyes of those who see the models arranged in the school museum; this was also our first impression; but we set ourselves to work, and in a few weeks we had made thirty of these models in the order of the series. We can thus declare with certain knowledge that the gradation really exists, and that it would be difficult to arrange it better. Let it be recalled, furthermore, that this series, as we have already said, is not the product of pure theory, which is almost always at fault in dealing with material needs; it is the fruit of long and patient experimenting. Mr. Salomon and his colleague, Mr. Johanson, tried many hundred models before they came to settle upon the series actually used. The gradation is obtained sometimes by the use of a new tool; sometimes by another method of handling a tool already familiar; sometimes by the nature of the wood, as soft or hard; by the greater dimensions of articles; by different modes of joining; by the intervention of the lathe or carving tools. The scholar who has executed the first twenty-five numbers could not successfully undertake at once the fiftieth or seventieth number. The intermediate steps of the series are necessary; there is no gap. The child who follows the regular course is never in the presence of insoluble difficulties; he can begin without hesitation, for the first works are simple and easy; from the first lesson of the Slöjd he sees his efforts end in a good result

which encourages him and stimulates his ardor; he aspires constantly to execute more difficult models, and he acquires every day the conviction more and more that he can succeed.

In the description which we have given of a lesson in Slöjd we have described the rôle of the teacher. It proceeds from this principle: that the development of the child should go on by itself spontaneously in order that he may learn to make use of his own powers, in order to overcome alone the difficulties and to resolve the problems which present themselves. It is the principle of self help, the application of which, in education, makes original and energetic men. The teacher could not reach this result by conveying merely his own knowledge to his pupils, by aiding them directly in their work, by undertaking himself to make the difficult parts of the model, or by giving the last touch to the work of the pupil. In the system of Naas the child begins and finishes his work alone; and he is able to do it because the series is, as we have said, perfectly graded. The teacher shows how the tool is handled in such and such cases, but he does not make his demonstration on the article which the scholar is to execute. The article being finished, he submits it to a comparison with the model; he makes its want of correctness appear, which, if possible, is immediately corrected by the pupil; if the work cannot be rectified, the teacher breaks it and throws it away, and it is done over again. When the child has correctly completed his model, he carries it home; it is his own work for himself; no one has worked with him; he can show it with pride, for he has applied his intelligence and his activity to a useful thing, which will be received with satisfaction by his parents. The modest homes of the peasants of Naas are thus constantly enriched by the work of the children. Is it not an admirable organization, well calculated to render the school truly popular, to introduce into families habits of serious industry, and to inspire in children at once respect for the work of the hands, and love for the domestic fireside? This is the true foundation of happiness and of morality.

We should however, remark a gap in this instruction. The pupils work only according to models in wood; at the same time they follow, at school, a course in linear drawing; why are they not exercised in applying directly their drawing to manual work? Surely, as it is organized at Naas, the Slöjd gives excellent results We have remarked it, and we repeat it, it develops largely manual skill, earnestness, attention, perseverance, and it inspires a taste for labor; but it holds the pupils too narrowly to the reproduction without variation of the models given. The child becomes a workman, active, correct, painsaking, conscientious; but he has not sufficient occasion to develop his spirit of initiative; his imagination cannot take the least flight, it is shut up in an iron circle. We think that manual labor would gain much as an educating force if it were intimately connected with instruc-

tion in drawing and geometrical forms. It is necessary to accustom the pupils to work, not only after models, but also after drawings. The educational value of drawing is indisputable. The methodical teaching of this subject habituates the mind to attention, teaches it to analyze, to combine forms; it gives to the thought a correct, exact, clear expression; it makes the imagination fruitful, develops the taste, makes the hand supple. In respect to manual labor, drawing has an importance which no one can fail to observe. By the purification of the taste, the adornment and multiplication of forms, it leads to the application of art to industry; it is the necessary foundation of manual occupations which aim to reproduce forms in material; as it takes account of no conditions except such as relate to form, it finds application in all industries, whatever may be the raw material upon which they are employed. This can be seen in all trades; the tailor designs his patterns; the carpenter works after profiles; the engraver begins by drawing a sketch of the ornamentation which he proposes to reproduce upon wood, stone or metal. For all material arts, drawing is the language *par excellence*, of a clearness, precision and conciseness, which the language of words cannot attain.

* * * *

These principles are not contested; why are they not applied in the exercises of the shops attached to schools? It has been said to us that this application, so evident in theory, meets great difficulties in practice; that children of ten to fourteen years do not know how to design or to interpret designs in such manner as to work correctly according to graphic representations. To what must be attributed the slight progress which pupils of the primary schools generally make in drawing? To the method followed, to the small amount of time given to this branch of instruction. Drawing is an art which requires many exercises, and daily application. When children are required to draw only one or two hours a week, the result cannot be satisfactory, and they are altogether fruitless unless a natural and progressive course is followed. The method of the academies is no more suitable for teaching drawing in the primary school, than the method of the colleges and universities is for teaching children the simplest notions of grammar, geometry, history or the natural sciences; here, still, and above all, it is necessary to start from the psychological principles established by Pettalozzi and Frœbel, to follow their applications through the entire course of primary instruction, and to constitute a progressive series of designs after nature, without entering into the domain inaccessible to the intelligence of children—of projections and scientific perspective. The eye and the hand must be exercised in the exact perception and faithful reproduction of material forms, by proceeding gradually from the simple to the composite. The child does not at the outset observe objects in their totality; the relief escapes him; he sees only surfaces, or, rather, the limits of surfaces; the tracing of

contours is a point of departure for the instruction in drawing in the primary school—contours as they are, and not as they present themselves to the eye, with the deformations due to perspective. This drawing of contours is the natural drawing. Observe the attempts of children when left to themselves; they reproduce the silhouette of objects which they see—houses, furniture, animals, etc.—by tracing lines which mark limits, without concerning themselves with relief. Perspective drawing is the higher degree; it cannot be entered upon successfully until towards the close of the primary studies.

But linear drawing, applied to the representation of plans, sections, profiles, etc., can be successfully taught to children as well as the simple combination of lines suggesting ideas of ornamentation, and it is precisely this drawing which should be combined with manual occupations.

In my view, the progressive order to be followed in the teaching of manual work based upon drawing, would include:

1. Working after models, and at the same time reproducing the models by linear drawing.
2. Working after models designed.
3. The composition of new forms imagined or designed by the pupils and reproduced materially.

We made at Naas an experiment which confirms this view. The pupils of the primary school drew plans and sections, on a scale of one-half, of two objects which they did not know, and which were not a part of the series; they were then directed to make the articles after their drawings; the results were very satisfactory. We reported the labor which was best done, and that which was least correct.

(c) *Who Should be Charged with Teaching Manual Work in the Primary School.*

To those who have seriously studied pedagogical questions, there is no occasion to demonstrate that any system of instruction is ineffective which has not an educational basis. Instruction and education are not two different things, but two faces of the same thing. As Herbart says, "There is no education without instruction, and it is impossible to understand an instruction which is not educative." But there are many persons who, although strongly interested in the schools, do not possess the necessary qualifications to resolve the purely pedagogical questions which they raise; it frequently happens even that they use their influence to promote ideas, programmes and solutions which, far from being favorable to the progress of instruction, are calculated to hinder it. It is to be feared that in what concerns the introduction of manual training into the primary schools, erroneous ideas will come to light and find advocates with this class of citizens who favor the school but are incompetent. Thus when one sets forth

this question of manual work among persons unfamiliar with primary instruction, the majority go straight to the following conclusions: First, that it is necessary to annex to the primary school a course of apprenticeship in different trades; second, that it is necessary to intrust this instruction to good workmen.

But both of these conclusions are false. We have already made the character and the aim of manual training in the primary school so far appear that we need not dwell upon the first; as for the second, it must be here considered.

The experiments of Basedow, Francke, etc., as to manual training —of which these illustratious educators well understood the educational bearing—failed principally because the instruction in this branch was intrusted to persons who considered the school as a workshop, and treated the pupils as apprentices. We have elsewhere noted the failure of method in the shops of apprenticeship at Gothembourg, where the instruction is given by artisans; on the contrary, wherever we have seen teachers or persons trained pedagogically engaged in the work, we have been able to recognize the superiority of their instruction. The purpose is not to initiate pupils into the mechanical processes of a trade, but to subject them to a course of methodical manual work, which exerts a happy educational influence upon them. Now artisans, even the most skilful in their trade, are in general incapable of giving suitable instruction in manual work in the primary schools. We say in general because exceptions can be found, selected workmen have sometimes succeeded, by following the pedagogical course of manual work, in acquiring a certain aptitude for instruction; but they are very rare.

The great obstacle to the introduction of manual training in schools is not a question of expense, but the difficulty of forming a capable body of teachers. It is far better to do nothing in this field than to undertake experiments with men who do not possess both the technical and the pedagogical fitness; for, in this case, one goes straight to a failure which forms the basis for declaring that instruction in manual work in the primary school has been practically demonstrated to be impossible. There is the real danger; it is necessary to avoid it. The teachers for manual work ought be recruited from among the primary teachers; those for the future should be prepared in the normal school. For present actual needs the only efficacious means is in organizing temporary courses; it is this which has been done in Sweden. When in that country the question was first raised of preparing teachers for instruction in the Slöjd, a tempest of indignant protestation arose in all quarters. "What! the primary teacher, this man charged with a kind of moral, literary and scientific priesthood was he to be lowered to the rôle of the workingman, and the school to be transformed into a shop? No teacher conscious of his proper dignity and of that of this mission would lower himself to handle the plane

or the saw before his pupils; moreover, teachers have already an occupation and employment sufficiently rude, and they are wanting in the technical capacity."

It is the history of all innovations. We saw the same manifestation in Belgium when there was a question about introducing instruction in gymnastics into the schools, and still later, about instruction in geometrical forms and the natural sciences. The importance of proposed reforms is not well understood at the outset. Well meaning persons, having no confidence in themselves, and with the utmost good faith, raise mountains of arguments which have been a hundred times refuted. Vain efforts! The progress goes on, and when the reforms are finally accomplished, they frequently receive the support of the very persons who first resisted them with the most conviction and energy.

In Sweden the tempest subsided little by little; the subject was discussed in the press and in teachers' gatherings, and the original opposition vanished. It came to be understood that the instructor did not lose dignity by putting on the workman's apron or blouse and showing the children how to work in material. Honorable and useful work cannot humiliate him who does it. There is but one true honor: to work for the good of humanity. Have we not seen men in high position secure reputation by devoting themselves to the labors of the shop in order to inform themselves, or divert themselves, or benefit their health? Among the cases cited are those of Louis XVI, who was a locksmith; Peter the Great, who became a carpenter in order to prepare the naval power of his empire; Maximillian of Austria, who forged arms; Luther, Frederick of Sweden and Louis XV., who were turners, etc. It is a well-known fact that at present, in the Royal family of Prussia every prince must learn a veritable trade, in order that his education may be as complete as possible. And the illustrious Gladstone—does he not seek repose from public cares by exercising the trade of a wood-chopper?

It is true that the primary teacher has already enough to do. He gives thirty hours a week to lessons; he needs, on the average, a dozen hours to prepare them well; add forty-eight hours for sleep and eighteen for meals, that makes a total of one hundred and six hours occupied out of one hundred and forty-four of the week, not including Sunday. There remains thirty-eight hours out of which it is possible for him to take some to be devoted to instruction in manual work. Moreover, the fatigue of this instruction will not go to increase that produced by his school work; the work of the shop, on the contrary, is an excellent hygienic exercise; it counterbalances the exercise of the brain. It appears to us, moreover, just to take account of this increase of useful work required of the teacher, by increasing his salary.

The Swedish teachers, having recovered from their first transient

prejudice, have resolutely undertaken this new task, the importance of which they understand, and at present the Slöjd is taught in about 600 primary schools. * * * * * *

The argument about the aptitude and preparation of the teachers is no longer put forward, since numerous individuals of the teaching body have proved by their example that the necessary capacity for the Slöjd can be acquired when one has the will and the courage to set himself about it. The problem is not to transform the primary teacher into a skilled workman, perfectly informed of all the practical processes of the trade; the aim is quite different, and in two temporary courses of five or six weeks each, separated by an interval of a year, a teacher can make the necessary preparation provided he continues to perfect his work by himself. We have described the organization of the temporary courses at Naas; that is a good model to imitate. In Belgium experiments of this kind have been made with reference to other branches much more difficult than manual labor. Instruction has been given successfully to numerous teachers by means of temporary courses, in the branches of knowledge necessary for teaching with profit the new branches inscribed in the programmes: gymnastics, drawing and the natural sciences.

But for the future, the preparation of teachers with reference to instruction in manual work, must be made at the normal school. In a recent conference, the directors of the Swedish normal schools unanimously declared that it was highly desirable to introduce the teaching of the Slöjd into these institutions. Up to the present time (1883), the Swedish government has taken no definite step in this direction, but a royal decree of September 11, 1877, shows that it desires to reach a solution. At the normal school of Carlstad the Slöjd has been successfully taught for several years. The experience of the normal schools of Finland, where manual training has been taught since 1863, also confirms this proposition.

In 1877, Mr. Salomon made an interesting inquiry. He addressed to 3,363 teachers of Sweden, a circular containing several questions relative to the teaching of manual training, among which are the following:

1. Do you possess some degree of practical knowledge in any manual work whatever?

2. Are you disposed to teach the Slöjd?

3. Are you willing to use your influence to introduce this instruction into the primary school?

One thousand five hundred and sixty-three teachers (46.50 per cent.) responded.

To the first question: 597 (38.2 per cent.) declared that they already possessed some technical skill; 820 (52.5 per cent.) that they possessed none; 146 (9.5 per cent.) did not reply to this question.

To the second question: 463 (29.7 per cent.) declared themselves

disposed to give this instruction themselves; 782 (50 per cent.) replied negatively; 318 (20.4 per cent.) did not answer this question.

To the third question: 1,090 (69.7 per cent.) declared themselves favorable to the introduction of this instruction in the primary school; 79 (5 per cent.) made the same answer but with certain conditions; 239 (15.3 per cent.) declared themselves opposed; 115 (10 per cent.) did not answer the question.

These answers have only a historical importance. Within five years the question of manual training has made immense progress in Sweden. It is better understood; the value of this means of education is proved by experience, and it can be affirmed that to-day the immense majority, if not all the Swedish teachers are favorable to this instruction.

There are in Sweden, as in every country, teachers to whom this instruction cannot be intrusted because of their age, their infirmities, etc. Furthermore, many classes of boys in the large towns are taught by women. In these two cases the instruction in manual work should be given to special teachers, pedagogically prepared, but never to workmen.

These results are of a kind to encourage those who, in other countries, are devoting their efforts to the constant improvement of popular instruction, and particularly to the introduction of manual training. As to the Belgian schools, we think that the preparation of teachers who desire to undertake instruction in manual training could be made, as at Naas, by means of temporary courses. In the same way, also, professors of Slöjd could be trained for the normal schools, in which, according to the programme of 1880, two hours a week in the lower divisions and one in the upper division must be devoted to manual training.

The expense of equipping a shop and the purchase of material would not involve a very considerable amount. * * * By dividing the pupils of the normal school into groups of about twelve or sixteen, the teacher of Slöjd would have from fourteen to sixteen hours a week of instruction in a school of one hundred pupils; consequently one man would be enough. This course should be intrusted to a primary teacher specially prepared for giving instruction in manual training; the professor in pedagogy should direct the instruction.

In order to assure the success of this new study, account should be taken at the different examinations of the progress made by pupils. The diploma also should state the fitness of the bearer to give instruction in manual training.

(d) *Pupils.*

At Naas manual work is taught only to pupils of the upper classes of the primary school. Mr. Salomon thinks, nevertheless, that this instruction should be given to all children, and commence as early as possible; but the point was to secure the success of the reform, and

to establish a practical method. The work was considerable, and it would have presented insurmountable difficulties if it had not been limited. The time was not ripe for a complete organization. To formulate theoretical principles and to support them by solid arguments is not difficult, for the elements of a work of this kind are found in numerous publications; it suffices to collect them and adapt them to the circumstances of the time; but it is quite different when one proposes to leave the domain of theory in order to establish a method conformable to principles, and confirm it by practice. The wisest course is to concentrate all one's activity upon one feature of the problem, and when a satisfactory solution of that has been reached, to complete the work already begun. This was the course adopted at Naas. It can be said that one reason why the teaching of Slöjd has advanced rapidly in the Swedish schools is that it was introduced first only in the upper classes. The average age of the pupils for working in wood after the method at Naas is twelve years, but it may be begun one or two years earlier; that depends upon the physical strength of the children. We have seen in the shops of the schools at Naas, Stockholm, etc., pupils of eleven and even ten years, who worked at the bench without difficulty.

In Sweden there are, on the average, 87 pupils—45 boys and 42 girls—for one teacher. Of this number there are about 20 boys of twelve years and upwards, who undertake wood-working. A teacher can give instruction in it to a group of a dozen pupils. When the number is greater, the oversight is too difficult; the pupils handle the tools badly, form bad habits of work, and make little progress. It is much better to begin with four or six, selected from among the most intelligent and most active, and when they have reached a certain degree of facility, to increase the number gradually up to twelve. The ordinary school, numbering twenty boys of twelve years and upward, will thus include two sections for manual work. Younger pupils, if vigorous, may be added.

The best measure of discipline is temporary or permanent exclusion rom manual training. It is applicable to negligent or careless students, and it is effective, because experience shows that children set great store by the occupations of the shop.

(e) *The Place.*

The class room is not convenient for wood-working; the benches and the tools cannot be conveniently arranged there, and after each exercise it is necessary to clear up.

When a new school house is built, it is easy to construct a separate room; in existing buildings one large class room can be divided, or a room which is not required for the general purposes of the school can be set aside, or a place can be prepared in the basement; otherwise a shop might be built (or rented) in the immediate neighborhood.

In all cases a school workshop should satisfy these conditions:

1. It should be in the neighborhood of the class rooms, but sufficiently removed from them to prevent the noise of the work from interfering with the other exercises.

2. The rectangular form is most convenient. Benches should be placed perpendicular to the long side.

3. For the simultaneous work of twelve pupils, the room should be at least 5.20 metres by 6 metres or about 2.75 square metres for a pupil. In cases where a lathe is set up, the length of the room should be increased 1 metre.

4. The height should not be less than 3.50 metres.

5. The windows should be large; their openings should occupy 25 to 50 per cent. as much space as the floor. It is convenient to place them in all the walls of the room as far as possible. The window-sill should be at least 1.50 metres above the floor, in order to avoid the breaking of glass.

6. It is well to wainscot the walls, in panels, to the height of 2 metres, and to paint the rest in oil colors.

7. The stove should provide for the preparation of the glue. The temperature should not exceed 12.5 degrees, for work at the bench develops warmth of the body.

8. A closet for tools is not indispensable.* Racks may be placed along the walls for the tools, which should be carefully numbered and arranged in order, so that it may be easy to find them.

9. If the work is carried on in the evening, it is necessary to suspend the lamps by horizontal wires so as to permit of sliding them to give light at different places on the bench.†

10. Near the shop should be a separate room for models and articles made.

11. The woods should be placed under a shed, well aired and not far from the shop. The latter should have a door on the side toward the shed. Wood can also placed in the attic.

(f) *Time.*

The exercises in manual work should continue at least two hours. A certain amount of time is employed in preparing the tools, the material, the models, and, at the end of the exercise, in replacing them; if only one hour is allowed, the work is broken off when it is hardly begun. Exercises of four hours are too wearisome. From two to two-and-a-half hours make a good average for children.

In order to obtain any results, it is necessary that the exercises in the shop be taken at least once a week. Thus, if the teacher has two or three sections, he will have to spend from four to six hours in

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*It is, however, desirable—Trs.

† This would be found an excellent arrangement, also, where electric light is used, the lamp being fitted with a light hook and suspended by a long cord.—Trs.

that branch of his teaching. In many of the Swedish schools the pupils spend from four to six hours a week in manual work. That is the most favorable arrangement in a school with several teachers; this work can be divided among them. It is better, in general to devote the morning to the intellectual studies and the afternoon to manual work. In certain places the studies are suspended one day in the week in order to devote more time to shop exercises.

(g) *The equipment.*

The equipment (*materiel*) includes the tools, the models, the raw material.

It is important to reduce expenditures to the minimum.

The experience at Naas has enabled us to arrange a list of tools necessary for the simultaneous work of six and twelve pupils. We publish this list with the price of tools in Sweden. The collection of models costs fifty crowns (about $14).

We have (on a previous page) set forth the principles according to which this series of models has been fixed upon.

As for the raw material, it includes nails, glue, and woods of different kinds. The wood is procured in plank or in timber.

At Naas it has been found that, on the average, the cost of wood for making the first twenty-five models of the series amounts to 1.88 francs; for the twenty-five following, 3.75 francs; for the last fifty, 15.62 francs; total, 21.25 francs.

If the hundred models are made in three years, the annual expense per pupil for the raw material is reduced, then, to seven francs; in the country districts it is less.

4. Conclusions.

Presented to the Minister of Public Instruction by Messrs. Sluys and Van Kalken, as results of their observations in Sweden:

1. Manual labor should make a part of the programme of the primary schools, in order to assure the integral and harmonious cultivation of all the faculties of the child, by the progressive and methodical development of manual skill or of technical aptitude, which, in the existing school organization, is not made the object of special exercises.

2. The instruction in manual work should be based upon the same general pedagogical principles as instruction in any other branches of the programme. It has for its aim the systematic cultivation of the pupil, and not apprenticeship to specific trades.

3. In order to secure for instruction in manual work the pedagogical character which it ought to have, the regular teacher should be required to give it.

4. Those now actually employed in teaching can be prepared for this part of their work by means of temporary courses.

The teachers for the future should be prepared for this instruction in the normal school.

5. The programme of instruction in manual work should include:

(a) For the first grade of the primary schools (pupils from six to eight years) occupations required by Froebel's method (Kindergarten), three hours a week.

(b) For the second grade of the primary schools (pupils from eight to ten years), the same occupations, but, more specially, modelling and working with paper and cardboard, three hours a week.

(c) For the third grade of the primary school, the superior primary school—the course preparatory to normal studies—(pupils from ten to fourteen and sixteen years), wood-working according to the method of Mr. Salomon, three to six hours a week.

(d) For normal schools, the theoretical and practical instruction of the pupil teachers in the subjects of the above programmes, a, b and c.

6. The instruction in manual work should be closely connected with instruction in geometrical forms and in drawing.

7. To secure a satisfactory teaching of manual work in the normal schools, a temporary course should be organized.

It would be useful to send some teachers to Naas to follow a complete course there.

Extract from Instructions for Teachers.

[Report of Royal Commission.]

5. The teacher must show the pupils the use of tools, explain the names and arrangement of the parts, and, both by word of mouth and by showing, make plain the mode of working, which must be done not only for the single pupils, but as often as opportunity affords, for the whole division at a time, while all keep still and give attention. That the pupils may learn to help themselves, the teacher must not, on the other hand, help them except when absolutely necessary. Still the finishing touches must be given to the work by the teacher, when the pupil cannot do it himself. The teacher must keep his attention directed to the exercise of the pupil in accuracy of eye, the awakening of his thought, and the opening of his eyes to the forms of objects.

Extract from Rules for Pupils.

7. The wages earned are entered in a savings-bank book made out in the pupil's name, but he does not receive this until he leaves school; and, as a rule, not then unless he has been a pupil of the school without interruption for three years, or three half-years after the age of 12 years. It may be forfeited by staying away from school, except in case of sickness or with permission of the teacher, or by the pupil rendering himself undeserving by his conduct in or out of school.

8. Pupils can make a purchase of their work at two-thirds of a moderate valuation; but in this case no wages are given for the work.

9. If the pupils furnish their material themselves, as in shoemaking, tailoring, or bookbinding, they have the product free.

10. Unconfirmed pupils pay for enrolment money three kronor (80 cents) per year, payment being made in advance; pupils who are enrolled at New Year pay two kronor. Those who are not in good circumstances can, on request, be let off with half payment. The inspector may demand of free pupils that they deposit fifty öre, which they receive back at the expiration of the school year if they observe the rules of the school.

Tools Used at Naas.

TOOLS.	Price of tools in Sweden.	Number of this tool necessary for simultaneous work in class of 12.
	K. O.	
1. Turning web,	1 30	3
2. Leveling saw,	1 40	3
3. Common saw,	1 70	4
4. Compass saw,	0 78	1
5. Back saw,	2 25	3
6. Jointer plane,	2 80	8
7. Jack plane,	1 05	8
8. Smoothing plane,	1 60	8
9. Curve plane,	2 00	1
10. Round-nose pinchers,	0 32	2
11. Flat-nose pinchers,	0 35	2
12. Pliers,	0 70	2
13. Tongs (Smith's),	0 60	3
14. Set of paring chisels,	3 40	2
15. Set of mortise chisels,	4 25	1
16. Gouges,	3 90	1
17. Flat file,	0 55	4
18. Round (½) file,	0 55	6
19. Rat-tail file,	0 55	4
20. Triangular file,	0 25	4
21. Center bit and augers (24),	5 25	1
22. Awl (and case),	0 90	3
23. Knife,	0 35	6
24. Draw knife,	1 00	3
25. Hammer,	0 65	8
26. Mallet,	0 55	6
27. Compasses,	1 00	2
28. Double compasses,	0 60	2
29. Maudrels,	0 14	6
30. Screwdriver,	0 30	3
31. Wabstrinque,	0 45	6
32. Priming wire (artillery) or spout (Ger. Löffeleisen,)	0 25	6
33. Screw-press,	1 00	2
34. Axe,	2 00	1
35. Beam compasses,	0 50	8
36. T-bevel,	0 65	2
37. Try square,	0 25	8
38. Glue pot and brushes,	1 60	1
39. Grindstone,	4 50	1
40. Oilstone,	0 45	3
41. Joiner's bench,	25 00	8
42. Metre (yard measure),	0 45	4
43. Turner's chisels,	6 00	1
44. Turner's gouges,	5 00	1
45. Sand-paper,	1 65	
46. Turning-lathe,	70 00	1
Total,	160 79 ($43 00)	

At Nääs a complete outfit for 12 pupils costs 600 francs = $120.

VI. SWITZERLAND.

[Extracts from the Report of the Royal Commission.]

In this country the elementary and secondary* education is gratuitous, and as to elementary instruction, compulsory. The system of instruction embraces the following schools:

A. Primary schools.
B. Secondary schools.
C. Evening schools.
D. High schools.

All children between 6† and 14 years of age must attend school, and must remain in the primary school until the age of 12.

On leaving the primary school at the age of 12, the children can either attend the secondary school, or they may, subject to the prescribed attendance at a supplementary school, enter into practical life. The school course in secondary schools extends over four years, and those entering such schools and remaining in them for two years (until 14 years old) are absolved from further school attendance.

Those who do not enter the secondary school are obliged to attend for four years at a supplementary school. * * * * This school is held on two half-days a week, and its chief aim is to enable the scholars to retain what they have learned in the primary schools, and, if possible, to develop it somewhat further. Although primary instruction in private establishments is permitted, about 97.5 per cent. of the children of all classes attend the public primary schools.

One of the best elementary Swiss schools visited by the Commissioners is that on the Lindescher Platz, in Zurich. The cost of building this school was £43,000 ($215,000), which amounts to £66 ($330) per head. Irregularity of attendance is practically unknown; all the children learn one foreign language; moreover, they are all taught drawing, and have object lessons in natural history. In the higher classes they are instructed in the rudiments of chemistry and physics, great pains being taken to place before the children well arranged specimens, which are contained in a school museum. These museums form very noteworthy features of the Zurich schools. Among the objects we found there were simple chemical and physical apparatus, chem-

* The Secundarschulen of Switzerland correspond most nearly to the British higher elementary or "graded" schools.

† From four to five years of age the Swiss children usually attend the Kindergarten schools, conducted according to the system of Froebel. The attendance at these schools is optional, and they have no State endowment.

ical specimens, geographical relief-maps, showing the Alps and their glaciers, typical collections of commonly occurring and useful rocks and minerals, excellent botanical models, as well as collections of insects carefully labelled, a complete herbarium, zoological and anatomical specimens and models; the collection, in fact, serving as a type of what such a school museum should be. Many of the specimens were collected and arranged by the teachers.

All the school subjects were taught intelligently and well. We were especially struck with the clean and tidy appearance of the boys, and there was a difficulty in realising that the school consisted mainly of children of the lower classes of the population.

The higher schools for boys in the Canton of Zurich consist of the Gymnasium or classical school, preparing for the University or the Polytechnic, and the Trade School (Industrieschule), which prepares for the Polytechnic, or for direct entrance into trade; both of these former schools being included under the term Cantonal School (Canton Schule).

The Gymnasium is entered at 12 years of age, after an examination, and consists of six classes, corresponding to one year each, so that the pupils leaving at 18 or 19, would pass from the 6th class with the leaving "certificate," enabling them to enter any University or Polytechnic school without an entrance examination.

The Industrieschule is entered at the age of 14, and consists of four classes extending over 3½ years, the first class being a preparatory one. From the second class onwards the school separates into two divisions—

(*a.*) A technical section;
(*b.*) A commercial section;

the former again dividing in the 3d and 4th years into a mathematical and a natural science section. The commercial section ends with the third year.

We visited the Cantonal School of the town of Zurich, consisting of a Gymnasium and an Industrieschule under the same roof. It contains about 500 pupils and 44 teachers. The class rooms are exceedingly large and airy, each fitted with desks for about 40 students, but capable of accommodating many more. In the Industrie school there is a well-arranged chemical laboratory, in which the students have six hours' practical work per week in the preparation of simple chemical compounds. There is a good collection of physical apparatus, common to the two schools. The lectures on physics are abundantly illustrated by excellent experiments, but the pupils themselves do no practical work in this subject. The teaching of the highest class is in advance of that usually found in similar schools in England. In connection with the physical collections is a small workshop containing a water-motor for working the dynamo, and used for the repair of apparatus, etc., but only by the teacher and his assistants. Draw-

ing forms an important feature of the instruction in this school, an average of six hours per week being devoted to this subject. * * *

The secondary schools for girls are analogous to the Industrieschulen for boys. One of these well-conducted institutions was visited by us. It is attended by girls between the ages of 12 and 16, of all classes, irrespective of social position. The class rooms are all large, and remarkably well furnished, as is the case in the boys' school previously described. With the exception of needle work and English, all the subjects were taught by male teachers. Among the remarkable features of this school was the excellent museum.

A school has been established for the higher training of girls, for which these secondary schools prepare them. The educational vote absorbs nearly one-third of the total expense of the Canton.

(a) Zurich Cantonal School—Time Table of Gymnasium.

I. Lower Gymnasium.

SUBJECT.	NUMBER OF HOURS DEVOTED TO EACH SUBJECT.			
	Class I.	Class II.	Class III.	Class IV.
Religion,	2	2	2	......
German,	4	4	3	3
Latin,	10	8	6	7
Greek,	......	7	7	7
French,	......	......	6	6
Mathematics,	4	4	3	3
History,	2	2	3	3
Geography and Natural Sciences,	3	2	......	2
Singing,	1*	1*	1*	1*
Writing,	2	......	......	......
Drawing,	2	2	2	......
Gymnastics,	2	2	2	2†

* An additional hour of choir practice optional.

† Three hours in summer.

N. B.—Religious instruction optional; also Greek in lower school, and Hebrew. Students in upper school who take Greek need not study English. Those students who take Hebrew may drop French.

II. Upper Gymnasium.

SUBJECT.	NUMBER OF HOURS DEVOTED TO EACH SUBJECT.		
	Class I.	Class II.	Class III.
Religion,	......	2	......
German,	4	4	3
Latin,	7	7	7
Greek,	7	7	7
French,	3	3	3
English,	3*	......	......
Hebrew,	......	4	3
Mathematics,	4	4	3
History,	3	3	3
Natural Sciences—			
a. Physics,	2	3	$\frac{1}{2}$
b. Physical Geography,	......	......	$\frac{2}{3}$
c. Chemistry,	3	......	......
d. Natural History,	......	2	......
Singing,	1†	1†	1†
Gymnastics,	2	2	2
Exercises with Arms,	1‡	1‡	......

* Will be introduced in all three classes.
† Half of the time devotedto gymnastics, for rifle practice, etc., in summer.
‡ Optional.

(b) Time Table of the Industrie Schule.

A. Preparatory School.

SUBJECTS.	Hours of study per week.
Religion,	2
German,	6
French,	6
History,	3
Geography,	3
Natural History,	3
Mathematics,	8
Caligraphy,	2
Freehand Drawing,	4*
Singing,	1†
Gymnastics,	2

* Two hours in winter.
† One hour optional.

B. Technical Division.

SUBJECTS.	NUMBER OF HOURS.		
	Class 2.	Class 3.	Class 4.
Religion,	2	. . . . .	. . . . .
German,	4	2	2
French,	5	5	3
English,	5	5	3
Physics,	. . . . .	4	4
Chemistry,	. . . . .	3*	2
History,	3	2	2
Geography,	2†	. . . . .	. . . . .
Natural History,	2‡	. . . . .	. . . . .
Mathematics,	7	6	6
Geometrical and Technical Drawing,	4	4	4
Freehand Drawing,	2	4§	2
Singing,	1‖	1‖	1‖
Gymnastics,	3	3§	3
Mechanics,	. . . . .	3	3
Practical Geometry,	. . . . .	1‡	4

NOTE B.—In the natural science division the classes in German, French, English, History, Physics, Chemistry, Mathematics, Singing and Drill are identical with the above; there are also the following added subjects: Mineralogy, 3 hours in winter only; Laboratory work in chemistry, 4 hours in winter; Botany, 4 hours in summer and Freehand Drawing, 2 hours.

NOTE C.—In the natural science division the classes in German, French, English, Physics, History, Drawing, Singing and Gymnastics are identical with the above; there are also the following added subjects: Chemistry, 5 hours; Mineralogy, 2 hours; Botany, 3 hours, and Mathematics 3 hours. Singing is optional in all the classes as is also the religious instruction.

C. Mercantile Division.

SUBJECTS.	NUMBER OF HOURS.	
	Class 2.	Class 3.
Religion,	2	. . . . .
German,	4	2
French,	5	5
English,	5‖	4‖
Italian,	5‖	4‖
History,	3	2
Geography,	2	2
Physics,	2	. . . . .
Chemistry,	3	2†
Knowledge of Merchandise,	. . . . .	1§
Algebra,	1	. . . . .
Mercantile Arithmetic,	4	4
Theory of Commerce,	2	2
Bookkeeping and Accounts,	1	2
Caligraphy,	2	. . . . .
Freehand Drawing,	2‖	2‖
Singing,	1‖	1‖
Gymnastics,	3§	3§

Choral singing not obligatory for any class. Exercises with military weapons and rifle practice on Saturday afternoons. Military drill one hour in winter.

* Four hours in winter. † One hour in winter. ‡ In winter only.
§ Two hours in winter. ‖ Optional.

(c) Partial Programme of the Zurich Polytechnic School.

V. SCHOOL OF AGRICULTURE AND FORESTRY.

A. School of Forestry (Course Five Sessions).

First Year's Course.	*No. of hours per week.*
Mathematics, with revision,	4
Experimental Physics, with revision,	4
Inorganic Chemistry,	6
Revision of the same,	1
Zoology.	4
Principles of General Botany,	3
Principles of Forestry,	3
Plan Drawing,	2

In the summer session there will be additional teaching in Organic Chemistry, Special Botany, Petrography, Preservation of Forests, with Applied Zoology and Botanical Microscopic work.

Second Year's Course.	*No. of hours per week.*
Plan Drawing,	2
Topography,	3
Roadmaking and Hydraulic Engineering,	3
Agricultural Chemistry,	2
General Geology,	4
Fundamental Principles of National Economy,	4
Theory of Climate as affecting Forestry,	4
Adaptability of varieties of Timber Trees for Forests,	2
Principles of Taxation,	3
Excursions and Practical Exercises,	1 day.

In the summer session there will be exercises in land surveying, vegetable physiology with experiments, principles of civil law, formation of forests, the history of State domains, and statistics relating to the same, business principles, excursions, and practical work.

Fifth Term.	*No. of hours per week.*
Principles of Business,	2
Laws of Commerce and Valuation of Timber and Forest Trees,	4
Practical Utilization of Forests,	3
Excursions and Practical Exercises,	1 day.
Land Surveying, Use of Theodolite, etc.,	3
Laws relating to Property,	3

B. School of Agriculture. (Total Course, Five Sessions.)

First Year's Course.

In this division the professors are entitled to allot to each student a special course of study in accordance with his requirements and capacity.

	No. of hours per week.
Mathematics, with revision,	4
Inorganic Chemistry,	6
Revision of same,	1
Experimental Physics, with revision,	5
Zoology, with special attention to the Animals useful and destructive to Agriculture and Forestry,	4
Principles of General Botany,	3
Fundamental Principles of National Economy,	4
Introduction to the Study of Agriculture, Theory of General Agriculture (Farm Management), Part I,	2

Plan drawing (3 hours, optional).

In the summer session the course will embrace Organic Chemistry, Experimental Physics, Anatomy and Physiology of Domestic Mammalia, Special Botany, Vegetable Physiology, Microscopic Work, Petrography, General Agricultural Management, History and Literature of Agriculture and Plan Drawing.

Second Year's Course.

	No. of hours per week.
Agricultural Chemistry, Part I (Nourishment of Plants),	2
General Geology,	4
Financial Economy (with special reference to the Taxation of Switzerland),	2
General Agriculture,	5
Drainage and Irrigation,	2
General Theory of Cattle Breeding,	2
Theory of General Farm Management, Part II,	3
Diseases of Cattle,	2
Agricultural Machinery and Implements,	3
Microscopic Exercises (with special reference to the Diseases of Plants)	2
Roadmaking and Hydraulic Engineering (3 hours, optional).	
Topography (3 hours, optional).	

In the summer term there will be Agricultural Chemistry, Exercises in the Agricultural Chemistry Laboratory, Microscopic Exercises, General and Special Cultivation of Plants, Breeding Cattle, Diseases of Cattle (especially Murrain), Horse Management, Shoeing and Breeding of Horses, Principles of Agricultural Machinery and Implements, Roadmaking and Hydraulic Engineering, Topography, Surveying, General Theory of Law and Theory of Farm Management.

Fifth Term.

	No. of hours per week.
Estimates of Agricultural Produce and Book-keeping,	2
Sheep Farming and Pig Keeping,	3
Practical Agriculture,	2
Agricultural Chemical Technology (Sugarmaking, Distillation of Spirits, etc.,)	2
Practical work in Laboratory of Agricultural Chemistry,	8
Vine Growing and Production of Wine,	2
Fruit Growing and Knowledge of Fruits,	1
Planning of Farm Buildings,	1
General Theory of Law,	3
Utilization of Forests (3 hours, optional).	
Critical Examination of the Rotation of Crops (2 hours, optional).	

(d) Educational Expenditure of the Canton of Zurich.

The budget of the Canton of Zurich for the whole of its education, amounts to 1,847,490 fr. ($369,498). The following are the principal items of expenditure:

	Fr.
Office expenses,	22,300
The University,	192,800
Contribution to Federal Polytechnic,	16,000
Gymnasium,	81,000
Industrie Schule,	44,000
Miscellaneous expenses on Cantonal school,	12,900
Veterinary school,	25,100
Normal schools,	54,950
Technikum at Winterthur,	84,200
Libraries and collections,	50,600
Scholarships and bursaries to teachers and students,	59,000
Gas, water and coals,	17,000
Primary schools,	1,010,700

	Fr.
Pensions, etc.,	108,550
Military drill,	2,500
Sundry subventions, Winterthur, etc.,	65,890
Total,	1,847,490

The estimated expenditure of the canton under all heads being, for 1882, 5,845,144 francs ($1,169,029), it follows that the education vote absorbs nearly 32 per cent. of the total expenses of the canton. In addition to the Cantonal expenditure on education, each Commune pays for its own primary schools. Thus, for example, the estimated outlay of the town of Zurich for 1881 for education purposes amounts to 437,900 fr. ($87,580). Of this total, elementary schools take 119,443 fr. ($23,888), 183,710 fr. ($36,742) are allotted to higher elementary schools, 15,290 fr. ($3,058) for the *Real Gymnasium*, 30,075 fr. ($6,015) for the higher girls' school and the normal schools for female teachers, 96,724 fr. ($19,345) for miscellaneous expenses, and 105,000 fr. ($21,000) for interest on loans for the erection of school buildings.

(e) Cotton Spinning in Switzerland—Factories of M. M. Heinrich Kunz, Windisch, near Zurich.

We found at the infant school that the children were being taught by Kindergarten methods, and had a large collection of sewing and plaiting patterns on paper, colored designs, boxes of toys, Noah's arks, bricks and sticks, etc., such as we find in the best schools in England. The desks, tables, and floor were scrubbed scrupulously clean, and the children were all neatly dressed and clean. They went through physical exercises, sang, counted and gave evidence of being intelligently taught. There is also a junior elementary school, of which the fees, as of the infant school, are 1*d.* (2 cents) per month. Mr. Wunderly believes that even a small payment encourages appreciation of the schools, and tends to foster a spirit of independence among the parents. The older children attend the Windisch free school at some little distance from the factories, where they receive a sound primary education, as good as may be obtained in the larger towns. The parents and villagers generally are encouraged to take an interest in these schools by the good example of Mrs. Wunderly, who actively shares her husband's interest in the welfare of their employés. She provides a Christmas tree annually for the school children, and a little meeting is held at which they sing and show specimens of their work and scholarship, and here she and her husband meet the children and their parents, and each child receives a present from Mrs. Wunderly's hands.

(f) Engineering and Machinemaking, Switzerland.

Although in the section of heads of departments, other qualties besides scholastic knowledge and training have always been taken into account; nearly all the head men in these works have been through the polytechnic or the technicum.

. . . .

Every polytechnic student expects to take a position higher than

that of the ordinary workman; but in the Swiss machine and engineering shops, which are comparatively few in number, students from the higher schools are so numerous that many of them necessarily begin as ordinary workmen, and some never rise beyond this position. With some of these highly educated youths it is rather a disadvantage to themselves that they should have remained at school till twenty years of age, because a few years must elapse before they possess the expertness of ordinary workmen, whereas the boys who begin wage-earning at fourteen, generally receive sufficient education in the elementary schools to enable them to perform intelligently all the work required of them. As *ordinary* workmen, assuming that there were no possibilities of advancement, it was represented to us that the boy coming to the shop at fourteen becomes, as a rule, a more skilled and valuable artisan than the highly educated youth coming at twenty. In actual experience of workshop government it does, however, generally happen that the highest positions are eventually secured by youths of superior education and scientific training, although in Switzerland the supply is greater than the demand, and consequently many must remain workmen, or emigrate to some other country where there is a better field for their scientific attainments. To sum up the evidence of the heads of this firm on this interesting question, it was held that if a workman possesses those moral qualities which fit him for a higher position, such as that of foreman or manager, the acquisition of scientific training is of the greatest value to him; indeed for the higher posts it is indispensable, whilst for foreman it is second only to a thorough knowledge of work and the management of men. There are many workmen and foremen possessing practical skill and high scientific knowledge who have not attended a polytechnic school, and there are some who have enjoyed the fullest advantages of the polytechnic school who are not only much inferior in practice, but are very deficient in scientific knowledge also, to others who have enjoyed fewer educational advantages. A manufacturer's son, who is intended for an industrial or commercial career, cannot do better than begin his education at the elementary school among the children with whom he will be connected in after life. He will learn to respect and admire the good qualities of his playmates; he will better understand their weak points and know how to deal with them. Good fellowship and sympathy between master and man are qualities that possess a commercial as well as a moral value. Moreover, in Switzerland the public free school is the *best* school for an elementary education. Mr. Hüber's own son attended a primary free school; after that the Real Gymnasium for a three years' course; he is there now, and his father expects him to get a general training in science and modern languages till he is turned eighteen. He will then enter the workshop for a year to learn the use of tools, and to obtain a general knowledge of the terms used in

the shop, the purposes of the machines, etc. From the shop his father hopes to send him to the Polytechnic School for three years. By this time he ought to be a thoroughly qualified engineer, able to take his place by the side of the capable men of all countries.

In going over these works, the Commissioners had a conversation with a very intelligent foreman engineer. After working in a shop as a boy, he attended the department for engineering in the Zurich Polytechnic, and having finished the course, he fulfilled the dream of all ambitious young men by traveling to England. There he visited some of the engineering works of Yorkshire and Lancashire; worked in the drawing office of one of the large machine makers at Oldham, and was employed in other capacities at some of the leading establishments in the North of England. * * * *

The educational facilities offered to the poor in Switzerland are beyond all praise, and are highly appreciated by them. Besides the free day schools there are free evening and Sunday schools, and in the Canton of Zurich, at least, the apprentices and workmen have only themselves to blame if they do not continue their education in any direction in which they may desire to excel. He looks upon the free schools of Switzerland as the mainstay of Swiss independence.

(g) Conversations—Education in Switzerland.

To illustrate the influence of the Polytechnic at Zurich upon one branch of chemical manufactures, it was stated by one of the most eminent and experienced of the professors, a gentleman thoroughly familiar with England, that the color manufactures of Switzerland owe their success, if not their origin, to the Polytechnic School. In support of this assertion the following figures were given as to the value of the coal tar manufactures of the previous year in various countries:

	£.	
England, ...	500,000	($2,500,000)
France, ...	300,000	($1,500,000)
Switzerland, ...	300,000	($1,500,000)
Germany, ...	1,600,000	($8,000,000)

So far as Switzerland is concerned, nearly the whole of the raw and semi-raw materials for the above products had been imported, and many of them from England. The products had been very largely exported to foreign markets. In the making of these dyes only one firm in England had succeeded thoroughly; most of the others had groped in the dark, without scientific knowledge to guide them. In the German works were trained chemists as competent to take up new work as old. Switzerland had taken a lead by means of the

higher chemical knowledge imparted to students in the laboratory, and she had supplied men for works at home and abroad, who in the dyeing industry alone had repaid, ten times over, the entire cost of the Polytechnic.

When there was a movement in the Federal Council for lessening the grant to the chemical department of the Polytechnic, it was shown by undoubted evidence that within a few years the chemical laboratories had been the direct means of bringing capital to the country to the extent of millions of pounds sterling, and that their usefulness was crippled for want of better accommodation. The movement for lowering the grant was defeated, and a proposal was carried for the expenditure of £50,000 ($250,000) upon a new laboratory.

LIST OF REFERENCES.

The following list of titles is not intended as anything like a full enumeration of the material consulted by the commission in the course of the inquiries prosecuted by the individual members, and in the preparation of the foregoing Report and Appendices. Official reports, programmes, courses of study, magazine articles, addresses and similar documents relating to every branch of the subject have been generously furnished and freely used. The following list contains the titles of only the most formal and important of the publications consulted, and they are given here merely as a suggestive aid to those who may be interested to pursue the subject further:

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INDEX.

Page.

Alabama Polytechnic, ... 55
" Tuskegee Normal School, ... 58

Barnard, Dr. W. T., Report referred to, ... 12
Bean, Col. Theodore W., Report to the commission, ... 25–34

Charity Organization Society of the City of New York, ... 38
Commission, Assignment of topics for investigation, ... 2
" Conclusions and recommendations of, ... 22
" Object of, ... 3
" Organization of, ... 1
" Resolution appointing, ... 1
Connecticut, ... 62–73
" New Haven Pub. Schools, ... 62

District of Columbia, ... 61

Fetterolf, Dr. A. H., Report to the commission, ... 35–40
Florida, ... 74–5
Ferry, Jules, address at Vierzon, ... 453–7
Foreign Countries, Manual Training and Technical Education in, ... 6–9, 423–585
France, Administrative Organization of, ... 423–4
" Calico Printing, ... 465
" Corbon, Senator, Report of, respecting Manual Exercises in the Primary Schools, ... 436–9
" Desmonlins, M., Account of Professional (Technical) instruction in the city of Paris, ... 444–50
" Designing for Textile Industries, ... 465
" Educational organization of, ... 424–5
" Engineering Works of Schneider & Co., ... 464
" Laws relating to Manual Training Schools, ... 457–8
" Manual and Technical Training in, ... 430–1
" Normal Schools, ... 462–3
" Paris, Central School of Arts and Manufactures, ... 468–70
" " Higher Normal School for Manual Training, ... 459–62
" " Technical Instruction in, ... 444–50
" Programme of Primary and Superior Schools, ... 432–33
" Programme of Professional (Technical) instruction, ... 433–4
" Resolutions respecting Manual Training, adopted by the International Congress at Havre, Sept., 1885, ... 459
" School of Arts and Trades at Chalons-sur-Marne, ... 467
" Silk Industry, ... 464–5
" Technical Education in, ... 423–70
" The different degrees of Education in, ... 425–30
" Tolain, Senator, Report of, concerning apprenticeship schools, . . . 439–43
" Vierzon, The National Professional (Technical) School, at, ... 450–7
" " M. Jules Ferry's address at the laying of the corner stone, . 453–7
" " Senator Tolain's Report as to the kind of instruction to be given, ... 450–2
" Women's Work Schools in, ... 464

Page.
Georgia, ... 76–81
" Atlanta University, ... 76
" School of Technology, ... 77
Germany, Apprenticeship Schools in, ... 481–2
" Beet sugar manufacture, influence of Technical Training on, . . . 488–9
" Calico Printing, influence of Technical Training on, ... 489–90
" Chemical Color Industry, influence of Technical Training on, . 485–7
" Conversations on Artistic and Technical Instruction, ... 482–5
" Engineering and Machine Works, ... 492–4, 496–7
" Higher Elementary Technical Schools, ... 480
" Iron Industries of Westphalia, ... 495, 6
" Polytechnic Schools in, etc., ... 471–6
" Royal Fachschule of Iserlohn, ... 497, 8
" Technical Education in, ... 471–98
" Technical Training in Prussia, ... 476–8
" Textile Manufactures, Influence of Technical Training on, ... 490–1
Girls—See Industrial Training for.
Great Britain, City and Guilds of London Institute, ... 510–12
" Finsbury Technical College, ... 512
" Manchester Board Schools, ... 512
" Owens College, ... 522–3
" Polytechnic Institute (London), ... 513–5
" Science and Art Department, ... 499–509
" South Corporation Industrial School, ... 521–2
" Technical Education in, ... 499–524
" Workshop school, Mather & Platt's, ... 515–20
Industrial and Technical Education in the U. S. (Appendix I), ... 50
"Industrial Education," "Scientific Education," "Technical Education" defined, ... 4
Industrial Training for Girls, ... 399–422
" " Boston public schools, ... 399
" " Brooklyn, Pratt Institute, ... 403
" " Cleveland public schools. 406
" " Lafayette, Ind., Purdue University, ... 407
" " Newport(Rhode Island)Indus. School for Girls, 409
" " New York City public schools, ... 411
" " Philadelphia public schools, ... 415
" " Pittsburgh School Kitchen, ... 419
" " Toledo—Manual Training School, Department of Domestic Economy, ... 421
Illinois, ... 82–95
" Beardstown public schools, ... 82
" Chicago Manual Training School, ... 84
" Peru, public schools, ... 91
" State University, ... 91
Indiana, ... 96–117
" Indianapolis public schools, ... 96
" Purdue University, ... 96
" Rose Polytechnic Institute, ... 107
Iowa, ... 118–120
" State Agricultural College, ... 118
Kindergarten, The, ... 21
Land Grant Act of 1862, ... 7
Legislation in Massachusetts, ... 28
" in New Jersey, ... 29
" in New York, ... 33
" in Pennsylvania, ... 34
" in Congress (bill pending), ... 34
Luckey, Sup't. George J., Report to the Commission, ... 47–9

Page.
Maine, ... 121–125
" State Col. of Agriculture and the Mechanic Arts, ... 121
Manual Training for young women, ... 21
Manual Training, from an economical standpoint, ... 12–16
" from an educational standpoint, ... 10–12
" in Reformatories, Dr. Fetterolf's report, ... 19, 35–42
" in rural schools, ... 18
" in the public schools, ... 16
" Purpose of, ... 8–10
" Success of, ... 17
" teachers, need of, ... 18
Maryland, ... 126–131
" Baltimore Manual Training School, ... 126
Massachusetts, ... 132–155
" Boston public schools, ... 132
" Cambridge Manual Training School, ... 142
" Institute of Technology, ... 135
" Springfield Manual Training School, ... 142
" Worcester Polytechnic Institute, ... 146
Mather, Wm., views on education in the U. S., ... 5
" Notes on Technical Education in Russia, ... 524–34
Minnesota, ... 156–172
" Minneapolis public schools, ... 156
" St. Paul public schools, ... 164
" The University of Minnesota, ... 157
Missouri, ... 173–180
" St. Louis Manual Training School, ... 173

Nebraska, ... 181–3
" Omaha public schools, ... 181
New Jersey, ... 184–205
" Elizabeth public schools, ... 184
" Montclair public schools, ... 198
" Newark Technical School, ... 199
" Orange public schools, ... 203
" The Stevens Institute of Technology, ... 187
" Vineland public schools, ... 204
New York, ... 206–245
" Albany High School, ... 206
" Cornell University, ... 214
" Jamestown public schools, ... 221
" New York public schools, ... 239
" Pratt Institute, ... 209
" The College of the City of New York, ... 225
" The Hebrew Technical Institute, ... 228
" The Industrial Education Association, ... 231
Normal Schools in various states; Dr. Schaeffer's Report on 43–7
" " Their relation to Manual Training, ... 19

Ohio, ... 246–269
" Case School of Applied Science (Cleveland), ... 254
" The Cleveland Manual Training School, ... 259
" The Technical School of Cincinnati, ... 246
" The Toledo Manual Training School, ... 261

Pennsylvania, ... 270–376
" Carlisle Indian School, ... 270
" Eastern Penitentiary, extracts from annual reports of Inspectors, ... 35–8
" Girard College, ... 272
" Haverford College, ... 272

Page.

Pennsylvania Lehigh University, ... 296
" Laws relating to Manual Training, Col. Bean's Report, ... 25–35
" Public Schools of, Industrial Education in, Supt. Luckey's Report, ... 47–9
" Swarthmore College, ... 369
" The Pennsylvania Museum and School of Industrial Art, . . . 283
" The Pennsylvania State College, ... 300–368
" The Philadelphia Manual Training School, ... 274
" Tidioute public schools, ... 373
Plates illustrating manual exercises, ... 105–6, 279–82, 305–69
Polytechnic schools in Europe, general review of, ... 478–80

Reformatories, table showing industries taught in various, ... 41–2
Rhode Island, ... 377
" Newport Industrial School, ... 377
Russia, Handicraft and Industrial School of Moscow, ... 532–3
" Imperial Technical School of Moscow, ... 527–9
" Technical Education in, ... 524–34
" Technological Institute in Moscow, ... 529–32

Schaeffer, Dr. N. C., Report to the Commission, ... 43–47
Scientific and Technical Education in foreign countries, ... 6–9
South Carolina, ... 378
" Brainard Institute, ... 378
Switzerland, Chemical Manufactures, influence of the Zurich Polytechnic on, 584–5
" Cotton spinning in, ... 582
" Educational expenditures of, ... 580–1
" Engineering and Machine Making, ... 582–3
" Polytechnic School, partial programme, ... 580–2
" Technical Education in, ... 575–85
" Zurich Cantonal School, ... 577–9
Sweden, Technical Education in, ... 534–74
[Condensed translation of Report of Messrs. Sluys and Van Kalken to the Belgian Government on "Instruction in Manual Work in Primary Schools for Boys."—Qualifications of Teachers, Equipment, Methods of Work, etc., See topics under sub-heads in the text.]
Sluys and Van Kalken, Report, ... 12, 534–74

Tennessee, ... 379
" The University of Tennessee, ... 379
Texas, ... 382–4
" The Agricultural and Mechanical College of Texas, ... 382
Tolain, ...

Virginia, ... 385–9
" The Virginia Agricultural and Mechanical College, ... 385
" The Miller Manual Labor School, ... 385

Wisconsin, ... 390–98
" Sparta public schools, ... 396
" The University of Wisconsin, ... 390
" The Whitewater State Normal School, ... 398